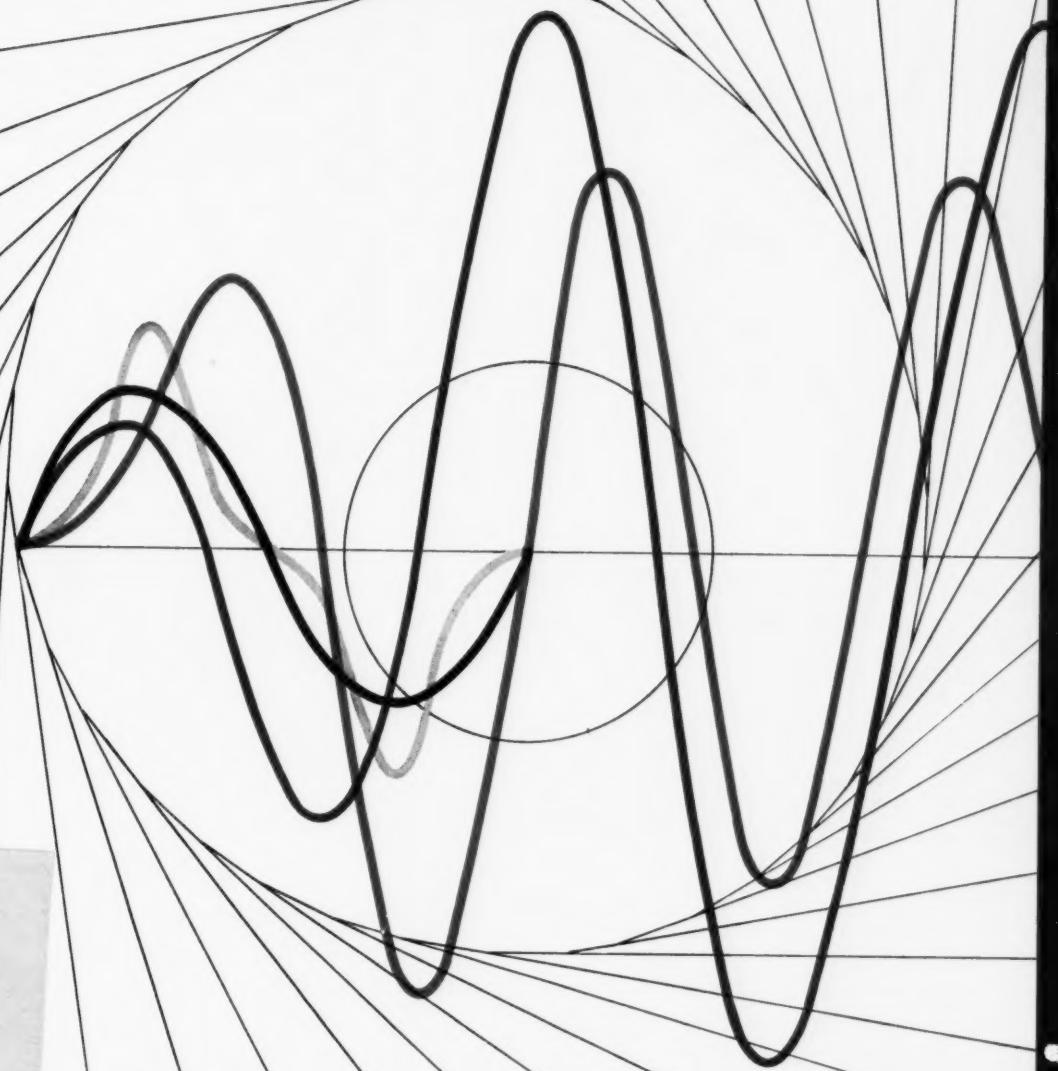


FEBRUARY 2, 1961

MACHINE

DESIGN

A PENTON PUBLICATION - BIWEEKLY

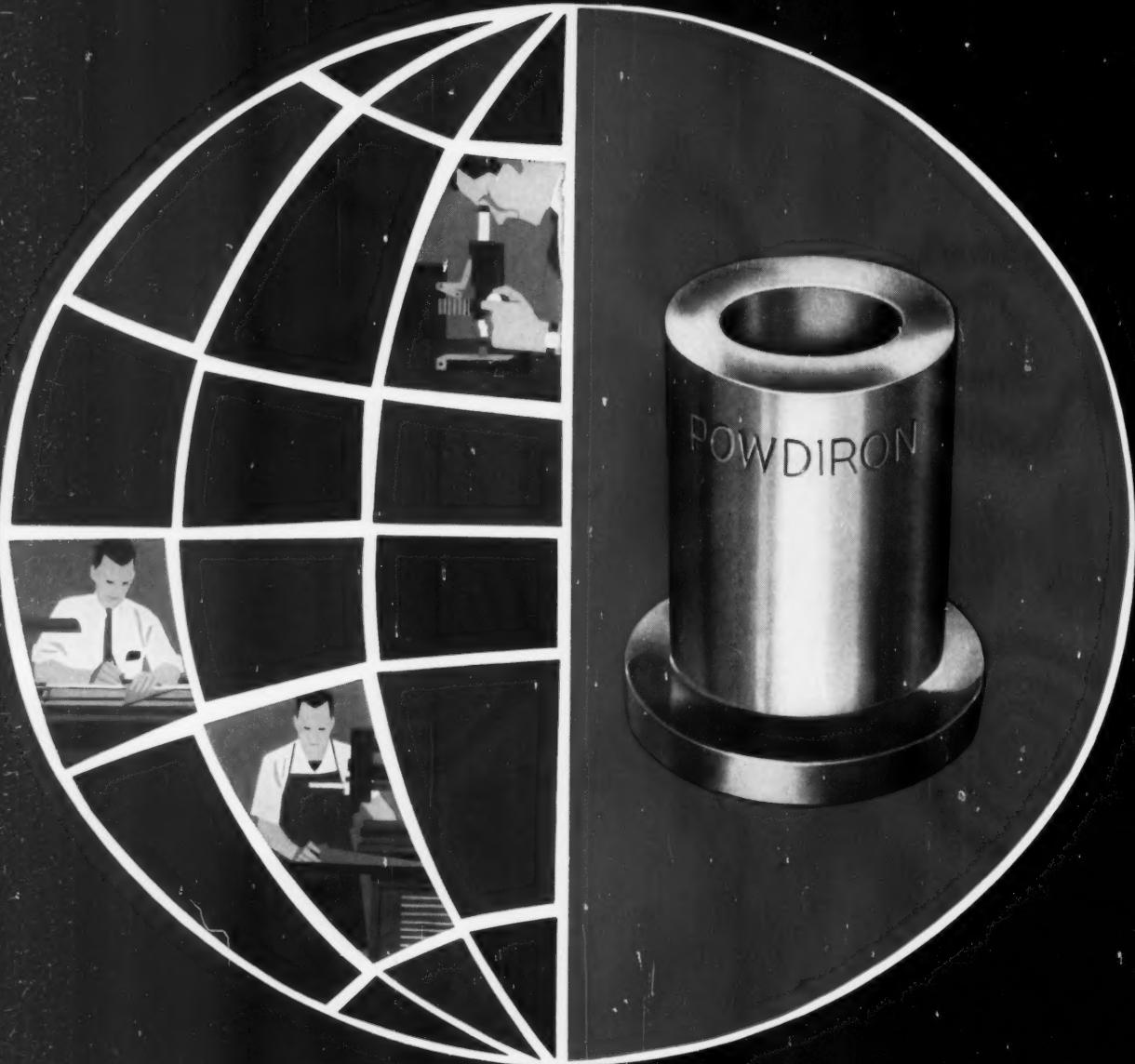


Cycloidal-Motion Cam Systems

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Mr. Stevens Rice
University Microfilms
313 North First Street
Ann Arbor, Michigan

FAENSWORTH



New Alliance—New Processes—NEW ECONOMY

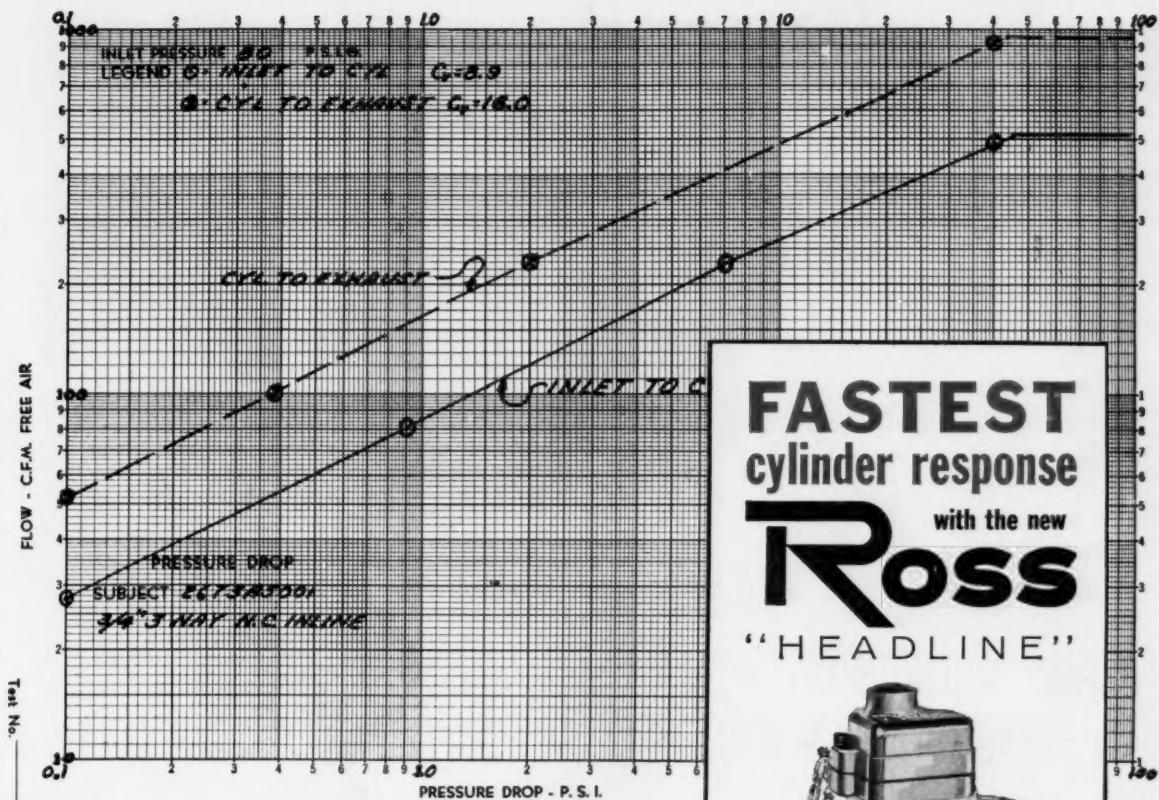
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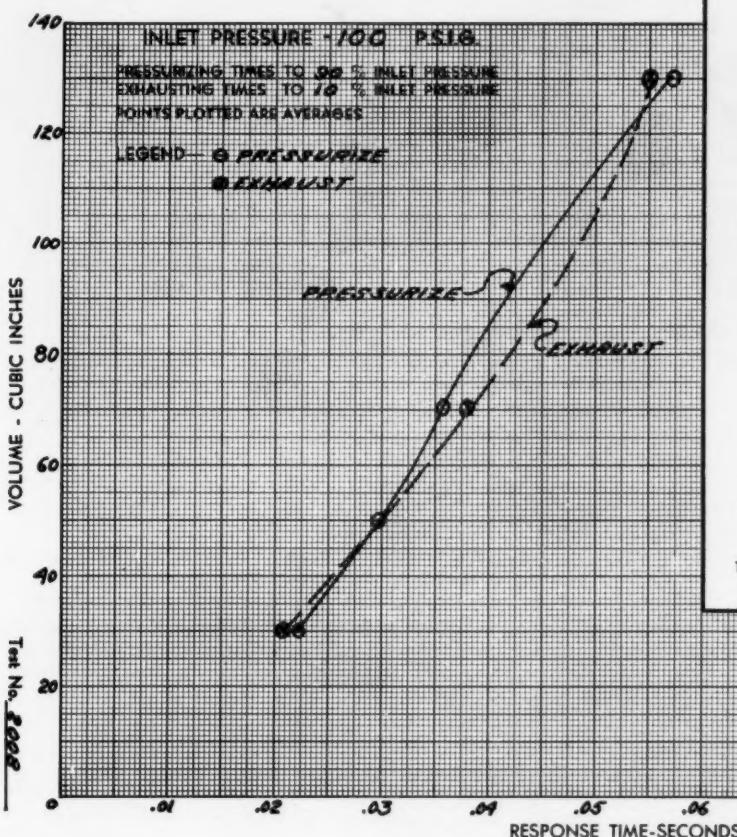
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Pioneer in Powder Metallurgy Bearings and Parts • Plants at Bound Brook, N.J. and Sturgis, Mich.

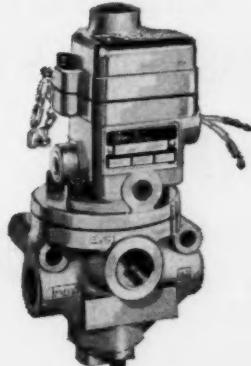
Circle 401 on Page 19



These graphs represent one series of tests with a random selected valve under specific conditions of pressure, temperature, humidity, fluid flow and voltage.



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NOW use a small valve to do a big valve's work

These actual test graphs speak louder than words. Here is the highest capacity valve size for valve-size of anything on the market. This saves you money! It lets you use a smaller valve to do a larger valve's work. See your Ross representative for details.

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PIPER JAFFRAY

THE BOSTONIAN SOCIETY

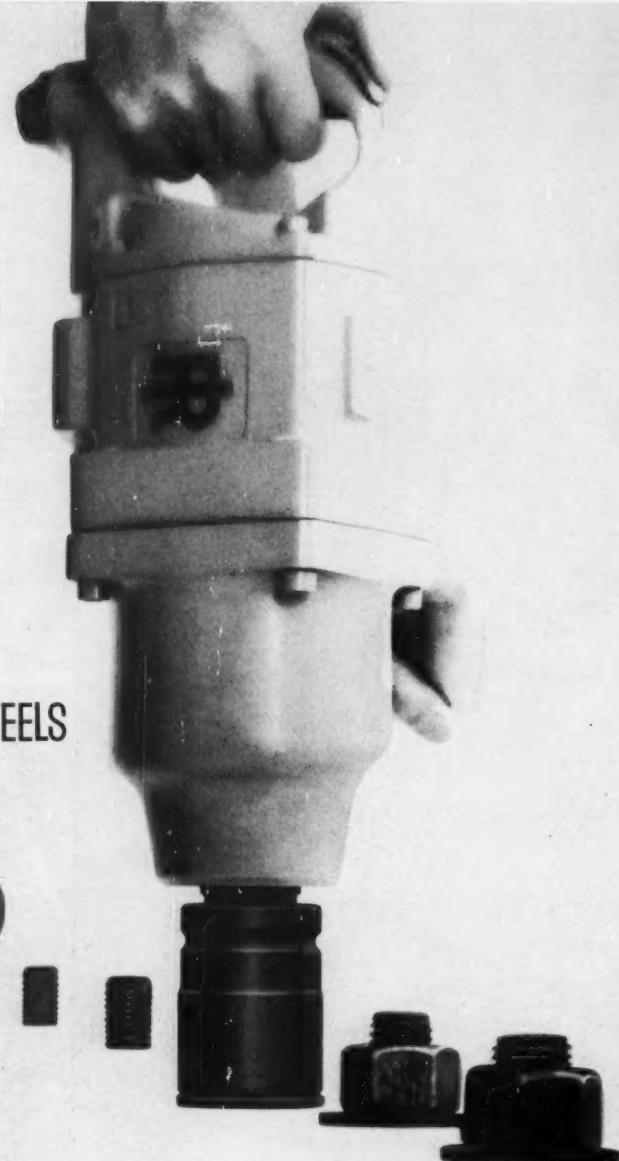
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February 2, 1961

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IMPACT STRENGTH OF
LEAD TREATED STEELS
**TORTURE
TESTED**

**3500 TIMES
PER MINUTE**

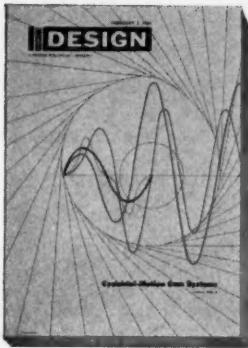
Switching to leaded* Aristoloy, Ingersoll-Rand was able to provide the high impact resistance (3500 per minute) and transverse strength required in these hammer case bushings. Use of leaded steel also cut machining time . . . eliminated tearing by the forming tool . . . extended tool life 10% . . . and shortened grinding time. Find out about these free machining lead treated STEELS—write for LEADED STEELS CATALOG today.

*Inland Leadloy License



DIVISION OF
**COPPERWELD
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ARISTOLOY STEEL DIVISION  4017 Mahoning Ave., Warren, Ohio • EXPORT: Copperweld Steel International Co., 225 Broadway, New York 7, N. Y.



February 2, 1961

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*Registered trademark for DuPont fluorocarbon resins. 60124L

ANACONDA®
METAL HOSE

Circle 406 on Page 19



Mobility: Cure for Creeping Airports

IN terms of the jet age, airports, like the dinosaurs, have become victims of their own size. The conventional terminal has grown into a sprawling complex, with long "fingers" extending out the aprons to far-flung gate positions. Several airports, now on the drawing boards, show connecting walks of nearly one mile . . . a point of no return as far as passenger convenience and airline economy are concerned.

A practical solution to this problem has been incorporated into the planning of Washington's new Dulles International Airport. Plush

mobile lounges, mated to the terminal within easy walking distance of the check-in counters, will carry passengers to and from airplanes.

Chrysler Corp. is building a prototype of the proposed vehicle, based on requirements set forth by the FAA. The mobile lounge is essentially a comfortable, self-propelled vehicle approximately 60 ft long and 15 ft wide. The passenger compartment will have the character of a well-appointed waiting lounge, in terms of layout, seating, lighting, air conditioning, and other comfort features. It will seat a total of 90

passengers, of which a minimum of 60 will be accommodated in permanent lounge-type seats, the balance in some sort of temporary seating. No lavatories or drinking-water facilities are contemplated, but smoking will be permitted.

The vehicle will be able to operate in either direction, with no penalty in maneuverability or driver visibility. Maximum cruising speed: Approximately 30 mph. The lounge will serve all four-engine aircraft presently in use or on order, but not smaller aircraft such as the Douglas DC-3 or Fairchild F-27.

Quick, positive positioning of the mobile lounge—a major design requirement—has been complicated by extremes in aircraft configuration and door operation. Chrysler determined that access ramps, originating from both the left and right front corners of the lounge, would be necessary to solve clearance problems in matching the various aircraft. Good seal has to be made between aircraft and lounge to maintain effective heating and air conditioning.



Fluid Power NEWS



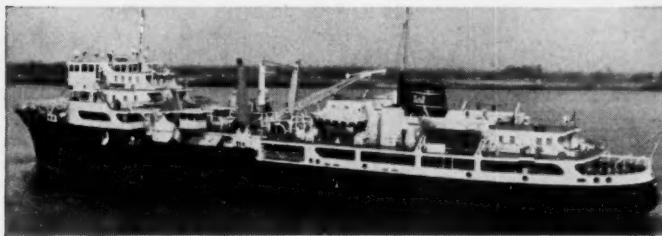
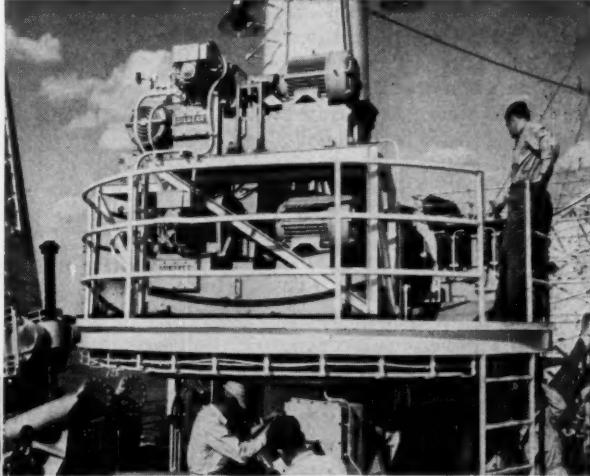
From Oilgear Application-Engineering Files

HOW OILGEAR HEAVY-DUTY ELECTROHYDRAULIC POWER AND CONTROL SYSTEMS SERVE OVER 125 APPLICATIONS ON SEAGOING HOPPER DREDGE "MARKHAM."

USER AND DREDGE DESIGNER: U. S. Army Corps of Engineers

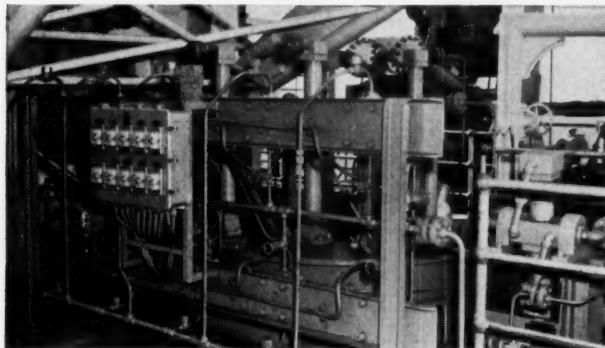
BUILDER: Avondale Marine Ways, Inc., New Orleans, Louisiana

The "MARKHAM"—constructed in accordance with A.B.S. and U.S.C.G. requirements, and largest suction dredge for Great Lakes harbor and channel maintenance—has Servocontrol Valve-equipped Oilgear Drives on Post Crane—Main, Whip, Topping Hoists and Rotating Machinery; and Anchor Windlass. Two Cargo Winches have Oilgear servo-motor lever hand-controlled drives. Oilgear Pumps, Cylinders, and Valves operate twelve 24-in. pump room valves, thirteen jetting valves, three sea valves, brakes and clutches on drag winches, forty mixing well gates, eight hopper dump gates, eight hopper distribution nozzle gates, and two gas collecting system valves . . . over 125 Oilgear Power and Control applications.



Seagoing Hopper Dredge "MARKHAM," launched June 10, 1959, is 339'6" long, has a 62' beam and 28' draft amidships. Hopper capacity—2,680 yards. Loaded Displacement—7,700 tons. Capable of dredging to a depth of 43'6", this diesel-powered vessel has a rated speed of 13 mph fully loaded, and 14½ mph light. The keel was laid at Avondale on July 29, 1958.

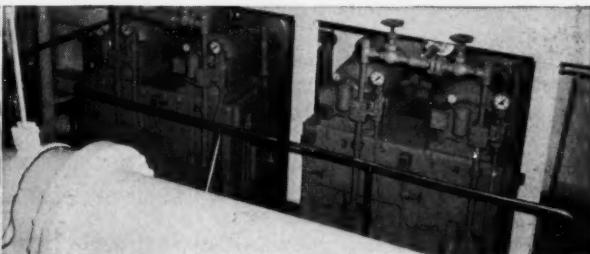
Post crane, with long boom, features remote, manual-controlled, Servocontrol Valve-equipped Oilgear Drives for all functions. Main hoist drive has a "DV-20" Pump and "H-20" Motor to handle loads to 20,000 lb at any speed up to 25 fpm. Whip hoist drive has a "DV-20" Pump and "H-20" Motor to handle loads to 4,000 lb at any speed up to 125 fpm. Topping hoist has a "DV-35" Pump and "H-20" Motor to raise full-loaded boom in 2½ minutes. Rotating drive with "DV-35" Pump and "H-20" Motor turns full-loaded crane 360° at ½ rpm. All drives are capable of handling a 50% overload. Manual operating levers, pushbutton stations, drive pressure gages, and pump stroke indicators are on a central control console.



One of the four mixing wells—ten Oilgear double-acting cylinders operate the gates for each well. Oilgear trunnion cylinder, at right, operates distribution nozzle gate. Oilgear "Power-Paks" supply fluid power for operating over 100 cylinders. Two cargo winches on the forward deck feature Oilgear "Any-Speed" Drives manually controlled from the forecastle deck. Each winch uses an Oilgear "DH-4" Pump and "H-8" Motor Drive to lift 3,200-lb. loads at any speed up to 50 fpm.

For Lowest-cost-per-year operation on ANY application . . . it's Oilgear! This fact has been proved by over 50,000 nominal horsepower of Oilgear Pumps on marine steering gear installations alone. Other marine applications include mobile drilling barges, elevators, catapults, capstans, large valve controls, lock and dam gates and bridges.

Circle 407 on Page 19



Two Oilgear "Power-Paks"—one is a "stand-by"—supply fluid power for operating over 100 cylinders that actuate 6 drag winch brakes, 8 drag winch clutches, 30 valves, and 56 gates. Each 600 gallon reservoir mounts two Oilgear "CG-60" Constant Displacement, Radial Piston Pumps and their electric drive motors. Each pump delivers 67.2 gpm at any pressure up to 1750 psi. The Anchor Windlass also features a Servocontrol Valve-equipped Oilgear Drive with manual control unit located on the forecastle deck. An Oilgear "DV-60" Pump and "H-60" Motor Drive (not shown) handles two 7,000-lb anchors simultaneously at any speed up to 5 fathoms per minute. An electric brake on the Oilgear Motor tailshaft is interlocked with the pump control.

For practical solutions to YOUR linear or rotary-Controlled Motion problems, call the factory-trained Oilgear Application-Engineer in your vicinity. Or write, stating your specific requirements, directly to . . .

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Union Federation Gives Up

WASHINGTON—Engineers and Scientists of America, an eight-year-old federation of engineering unions, has been dissolved. An experiment in unionization, ESA had internal difficulties several years ago because of its insistence on "professionalism first" and never recovered.

ESA's troubles started in 1957 when several major affiliates withdrew to form their own group—Engineers and Scientists Guild. Reasons given were that ESA had made the Taft-Hartley definition of a professional a criterion for membership in any of its unions and had de-emphasized collective bargaining. These two issues split the federation wide open.

Final blow was the withdrawal (a few months ago) of the Association of Professional Engineering Personnel. APEP claimed the federation was financially unable to take

any positive action. ESA president Joseph Amann admits the shortcoming but contends it was due to unrealistic dues of \$8 per year received from each engineer-member. According to Mr. Amann, the dues were insufficient to support action programs.

Major difficulty encountered by ESA, according to the National Society of Professional Engineers, was the reluctance of engineers in industry to support unionism in any form. Even in their few established bargaining units, ESA affiliates have been able to recruit less than 50 per cent of the engineers.

To sum up the experiment, Mr. Amann predicted engineers in industry will eventually organize, but they will first have to choose between the professional unionism offered by ESA and the labor unionism offered by AFL-CIO.

Topics

Science visits the scullery to solve an atomic-age problem. Storing uranium at the Nucleonics plant of Aerojet-General Corp. posed a problem because of several requirements for the container to be used: It had to be small, since large amounts of uranium can't be stored in one place; it had to be water-tight, because wet uranium is dangerous; and it had to have a lid that wouldn't come off and permit the contents to spill. At the suggestion of an employee who is also a housewife, they are now storing the uranium in pressure cookers.

• • •

Ringing up a reference is the way to get books at the University of Delft (Holland) library. In the "Biblio-phone" system, each book is assigned a seven-digit code number, and the student simply dials the number of the book he wants. A series of lights go on, directing him to the corridor, cabinet, shelf, and exact location of the book. If the book is not in its place, the dialer gets a busy signal.

• • •

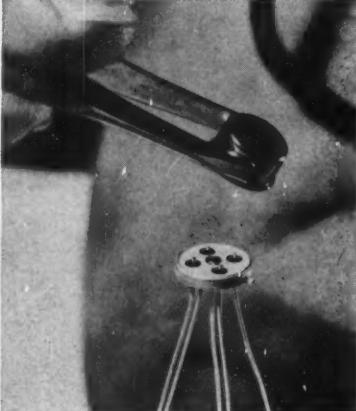
Car cards, billboards, subliminal TV commercials, and now—space writing. Advertising in orange letters against the evening sky, visible for hundreds of miles, is a "real possibility" for the future, according to Wallace Harper of Lockheed's Missiles and Space Div. Mr. Harper, a ceramist, and Ralph Armstrong, a high-temperature metallurgist, developed a method of tracking spacecraft descending from orbit with a sodium vapor trail, which would glow orange-red in near-space. Sodium vapor works like a gigantic lamp at these altitudes; a trail from a space ship would be stable for about 30 minutes. Commercial adaptation must await a means of programming words.

• • •

Speedy paymaster: A Minneapolis-Honeywell 800 electronic data-processing system recently processed a 10,000-man industrial payroll in 2.75 minutes. In this time, the computer updated a master payroll file, calculating each employee's gross and net pay, Social Security and withholding taxes, personal deductions, and payments for government bonds.

• • •

A thinking robot is being developed at the University of London. Among its accomplishments are to be the ability to distinguish friends from strangers and important problems from unimportant ones. The British scientists also plan to endow their machine with speech (in the form of electronic squeaks), sight, and skills such as reading and writing.



Two identical transistors, built as a single unit by Radio Corp. of America, increase voltage of low-power sources.

Electronic 'Siamese Twins' Boost Power

NEW YORK—A small but mighty solid-state device, called a twin planar—or more informally—the "Siamese Twin" transistor, is composed of two silicon transistors with a common collector and is constructed "like a ship in a bottle." It promises greater power for consumer, industrial, and military electrical devices.

- In space vehicles, it could substantially amplify power from a solar cell to transmit information back to earth.
- In industry, it could be used in automatic-production controls, laboratory instruments, and temperature regulators.
- Consumer equipment could take advantage of its ability to step up a 12-v automobile battery output to 110 v.

Because its two silicon transistors are identical, the "Siamese Twin" can be made to amplify electronic signals, convert them from dc to ac and back again, regulate their power or flow, subtract one signal from another and amplify the difference (as in a differential amplifier), and perform a variety of other jobs.

According to Ed Johnson, chief engineer of RCA's Semiconductor &

Materials Div., a planar transistor is constructed in such a way that all its electrically active areas are inside the semiconductor crystal from which it is made. These areas are constantly protected by the "skin" of the crystal itself even during manufacture. Thus, the ship-in-a-bottle analogy. Result is a transistor that is "inherently rugged, more stable, and longer-lived."



There's an answer to *your* electric heating problems in Vulcan's versatile line of heating units, components, and equipment.

A wide range of sizes, types and ratings is available to meet a variety of heating needs: *cartridge heaters* for insertion into machine parts, dies, platens, molds, presses, etc.; *tubular heaters* for clamping to metal surfaces, insertion into machined grooves or casting into metal forms and

machine parts; *strip heaters* for space or conduction heating; *immersion heaters* for all kinds of liquids. And in addition to components, Vulcan offers complete units such as air duct and radiant heaters for comfort heating, as well as circulation and fuel oil heaters.

Rely on Vulcan *versatility* — in product, in engineering, and in service — for your complete heating needs. *Write for catalog.*

Versatility in Electric Heating

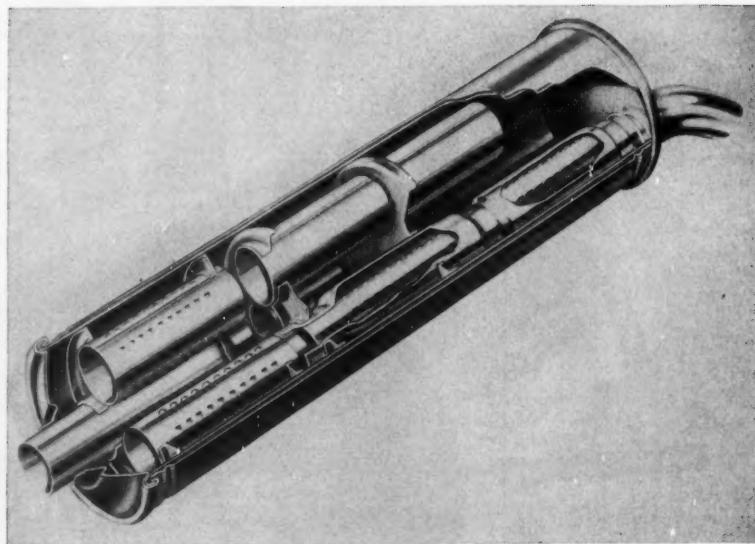
VULCAN ELECTRIC COMPANY • DANVERS, MASSACHUSETTS

New Stainless Is Standard in T-Bird Muffler

PITTSBURGH — American production cars are finally getting stainless-steel mufflers. The first, now going on '61 Thunderbirds, contains 7 lb of stainless parts (those that are most likely to rust out) and 6 lb of other materials. The new mufflers are expected to last at least three times as long as conventional types.

Key to the development is a new stainless steel (MF-1) from Allegheny Ludlum Steel Corp. MF-1 is five to six times more corrosion resistant than aluminized steel, 15 to 18 times more than steels commonly used in auto mufflers. Unusually ductile and very easy to weld, the new stainless has a chrome content of about 11 per cent. Titanium and other elements are added to tailor its properties for automotive mufflers.

Now that Ford has paved the way, at least one manufacturer says his company is considering a line of stainless replacement mufflers.



Standard equipment on the '61 Thunderbirds, Ford's new 13-lb muffler contains 7 lb of stainless steel. Inner shell and one baffle are 0.36 gage; heads are made from 0.48 gage. By specifying stainless steel for parts likely to rust out, Ford designers expect to increase muffler life three-fold.

Metals Matters

Atomic bond . . .

of an electrical contact facing of precious or semiprecious metal to a base metal rivet body is made in the Atomiclaid process developed by Gibson Electric Co., Delmont, Pa. Advantages claimed for the process are improved electrical, mechanical, and thermal capacities; cost reduction; and use of the precious metal only in the area and thickness required by the application. Area may range from a small, centered ellipse to coverage of the entire rivet head; thickness can be from 0.005 in. up to 85 per cent of the total head thickness. Present facing materials include silver, silver alloys, gold and many of its alloys, and many sintered materials. Rivet types are flat, full-crowned, and conical facings, with base metal shanks in solid, indented, or tubular forms.

Cold-pressed tungsten . . .

is suitable for rocket components that must withstand intense heat. The largest units produced by this method, according to General Electric Co., are its 160-lb tapered cylinders used for

exhaust ports in Polaris and Minuteman solid-fuel missiles. In the cold pressing process, metal powder is subjected to hydrostatic pressure of 25,000 psi and sintered before machining, forging, or rolling. Pressure chambers used by GE are barrels from 16-in. guns salvaged from World War II battleships.

Columbium stabilizes carbon . . .

and increases yield strength of carbon steel. Only $\frac{1}{2}$ to 1 lb of columbium per ton of steel provides sufficiently increased strength to permit a savings of 35 per cent in weight compared with regular carbon steels, according to Molybdenum Corp. of America.

Coating cadmium . . .

by an inexpensive, single-dip chromate conversion process is announced by Hanson-Van Winkle-Munning Co. The easy-to-use Chem-Rite C-55 process enhances the brightness of the cadmium deposit and produces a clear chromate surface, according to the developer. Its chief use will be to provide a protec-

tive coating that doesn't discolor or lose its brightness during long shelf life.

Nickel battles corrosion . . .

in coatings being developed at Inland Steel Co., Chicago. Coatings containing a high percentage of nickel, with chromium boride or tungsten carbide added to improve wear properties, are sprayed, dipped, or painted on metal surfaces. A reducing atmosphere converts the nickel coating into a surface which does not peel or crack.

Welding 0.0001-in. wire . . .

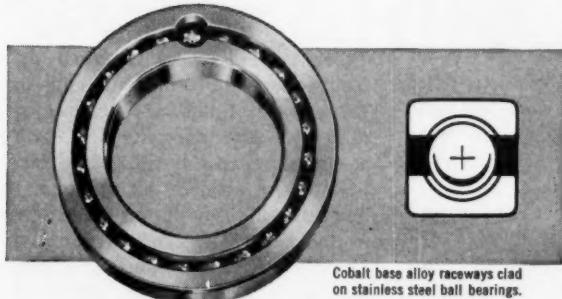
is done with high-frequency sound waves instead of heat, using an ultrasonic hand welding and soldering unit for small wires and pieces of metal made by Cavitron Corp., Long Island City, N. Y. Flux is unnecessary before soldering, because the sound waves remove any oxides on the metal's surface. The Cavitron kit comes with four tips for various operations; an attachment for welding plastics is among a number of other tips being developed.

N/D PROGRESS REPORT

nuclear energy section of research and development

THE EVOLUTION OF SPECIAL ALLOY BALL BEARINGS FOR CONTROL ROD DRIVE MECHANISMS IN WATER MODERATED, LIQUID METAL AND GAS COOLED REACTORS

Since 1949, New Departure's Nuclear Energy Section of Research and Development has been working in the development of special ball bearings for nuclear reactor applications. These applications have posed highly unusual design problems in that, for example, such obstacles as high purity water environment and radiation were never before contended with by a ball bearing manufacturer. Following is an outline of the most significant engineering developments in nuclear reactor ball bearings including current N/D projects on ball bearings for future nuclear reactors in land, sea and air installations.



Water Moderated Reactors—In the early days of nuclear reactor development, it was assumed that standard ball bearings would operate satisfactorily in the water moderated system control rod drive mechanisms. However, standard bearings seized, galled, corroded and wore severely in the high temperature, high purity water environment.

New Departure, in cooperation with a leading metallurgical firm, developed present techniques for making ball bearings from cobalt base alloys. These bearings with refinements are currently being used on a majority of the control rod drive mechanisms operating today.

Gas-cooled Reactors—At the present time, New Departure's Nuclear Energy Section is working on new ball bearing designs, theories and materials for gas type reactors employing helium and other gases, to be used in land, sea and air applications.



Liquid Metal Systems—New Departure has produced test samples for operation in liquid metal medium. One project recently completed was the development of design criteria for friction wear and scoring resistance of bearings lubricated with liquid mercury.

Cobalt Alloy Clad Upon Stainless Steel—N/D continued development work on cobalt base alloy bearings because some proved sensitive to shock loading. The result was the development of a technique of cobalt alloy clad upon stainless steel on which N/D holds the patent.

NS Savannah—More recently, New Departure was asked to assist in recommending ball bearings for the reactor to be used in the NS Savannah. In this application, the bearings are to run unlubricated in a high temperature, high pressurized water environment for a given number of revolutions. Following design recommendations, N/D developed the ball bearing for use in the prototype assembly, and is currently supplying production bearings for the NS Savannah's control rod drive mechanisms.



N/D Performance—With a history such as this, N/D engineering experience and facilities are ready to help you meet stringent operating requirements as well as tight delivery schedules.

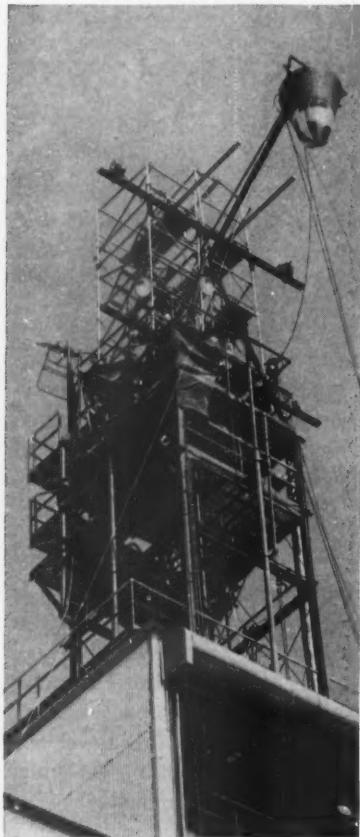
If you would like ball bearing application assistance, contact the N/D Sales Engineer in your area, or call or write New Departure, Division of General Motors Corporation, Bristol, Connecticut.

NEW DEPARTURE

BALL BEARINGS • PROVED RELIABILITY YOU CAN BUILD AROUND

Drop tests for Discoverer and Trailblazer II provide

Rehearsals for Re-entry

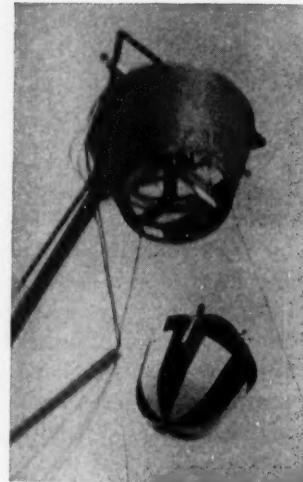


STATE OF THE AEROSPACE ART is moving so fast that designers must continuously improvise, invent, and design apparatus to obtain performance data. Problems that must be solved before astronauts can be brought back safely require new approaches to instrumentation and new types of equipment. High-speed photography at Lockheed is shedding light on the action of nose cones in the atmosphere, and special-purpose NASA missiles will soon start firing capsules back toward earth to provide re-entry data.

Filming the faults

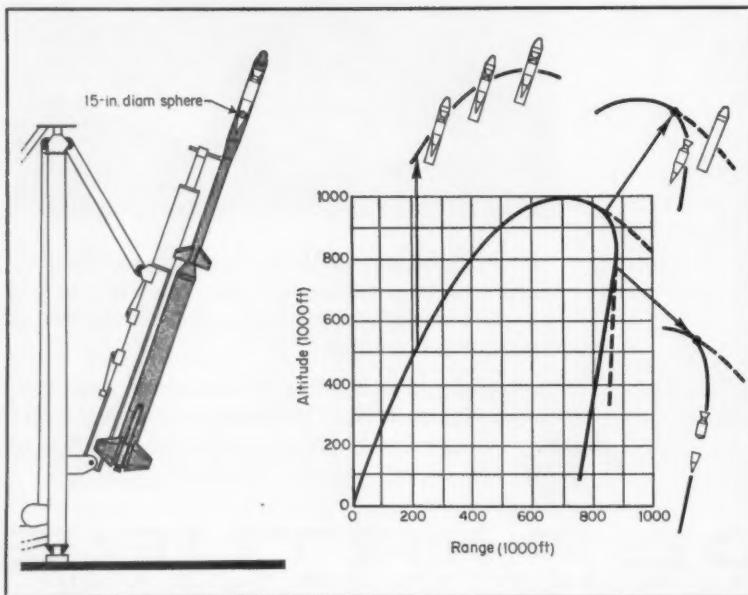
Flight-test data showed that the Discoverer satellite was unstable on re-entering the atmosphere, so Lockheed Missiles and Space Div. set up tests to correct the situation. After the test area was rigged for photographic coverage, capsules were dropped from a jury rig on top of a static-test stand (left).

Knowing free-fall distance and the programmed firing times, Lockheed engineers positioned two cameras to cover each critical point in the drop (paired cameras provided



accurate attitude-change data). Other cameras were mounted directly above the drop path and on the ground. Films were calibrated to provide base time references, such as rocket-ignition, burning time, etc.

Photos of axial instability (right) and other flight faults led to changes in the capsule design. As a result, Discoverer XIII became the first man-made object to be recovered from an orbit around the earth.



... and upside-down rockets

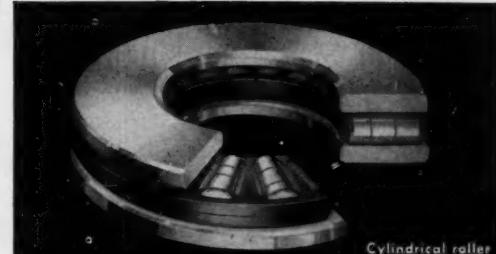
Trailblazer II, now being fabricated by Atlantic Research Corp., is designed to propel small nose cones into space, then fire them back into the atmosphere. First two stages of the 50-ft long research vehicle will fire in a normal manner. After the second stage has separated and the package has coasted to peak altitude, third and fourth stages ignite and speed the payload back toward earth at 17,000 mph (left).

Rather than attempting to turn Trailblazer around at peak altitude, ARC engineers designed return-stage rockets to fire in the upward direction. By this technique, they were able to make the lightweight research tool highly reliable, yet simple. NASA plans six firings of Trailblazer II in the spring.

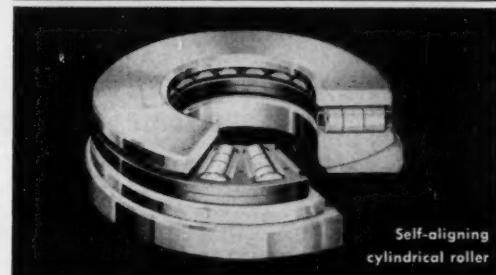
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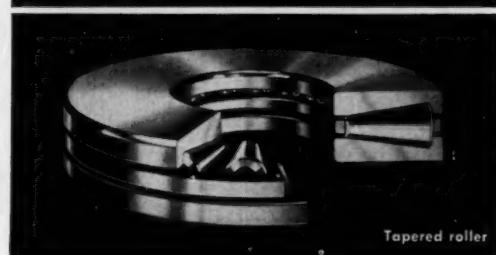
Torrington offers these basic types of thrust bearings.



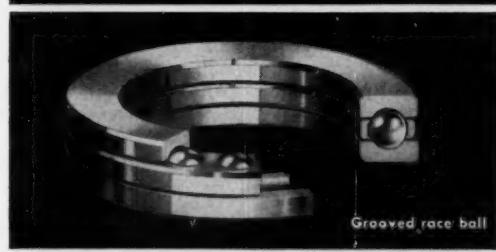
Cylindrical roller



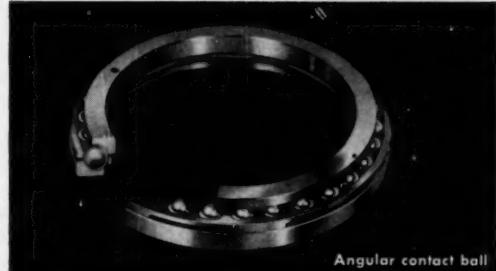
Self-aligning
cylindrical roller



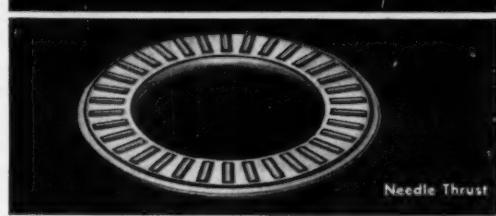
Tapered roller



Grooved race ball



Angular contact ball



Needle Thrust

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South Bend 21, Indiana, Torrington, Conn.



State-of-the-Art Supersonic Transport

Transport version of the B-58 bomber is proposed by Convair as a means of putting the U.S. ahead in supersonic air travel. Converted Hustler would cruise at about Mach 2.5, carry 52 passengers. Design changes would involve an enlarged fuselage, new engines (P&W J-58s; 30,000 lb thrust without afterburning), and the addition of a horizontal tail. Convair says cost of conversion would be reasonable because of

previous B-58 fabrication and flight experience. Preliminary flights would first be carried out with a current B-58 carrying a five-passenger people pod to show reactions of passengers to the unusual environment of a supersonic cabin. First flights of full-scale transports would then begin sometime in 1963. NASA will use a B-58 this year to evaluate the craft's handling characteristics in simulated commercial use.

Metric Controversy Continues:

DETROIT — Fifty years ago, conversion to the metric system in the U. S. would not have been too frightening. The idea was rejected, however, and the great debate has rumbled on ever since.

Today, no revolution of any consequence is being pushed by metric enthusiasts. They favor instead a program of orderly evolution. To the opponents, however, even this is unsettling, as was illustrated at the recent SAE Exposition in Detroit. A series of distinguished speakers came out either for or against (or remained on the fence) regarding adoption of the metric system in this country.

Grass-Roots Approach

Prof. Carl Kayan of Columbia University's Mechanical Engineering Dept. urges that we begin immediately to prepare and condition the public for changes in our unit-systems, even though the change might not involve complete conversion to the metric system. Decimalization could be the first step. It would not only lay the necessary groundwork for ultimate adoption of the metric system, but

"Adoption, world-wide, is logical and necessary . . . in terms of simplification it stands alone . . . cost of conversion could ruin many U. S. firms . . . it's doing a good job in the lab; leave it there."

would make everyday life a lot simpler. Teaching decimals from the early grades on would be a natural step in the U. S., Prof. Kayan explained, "since we have a practical penny-dime-dollar philosophy entrenched in children even of preschool age."

Which Metric System?

Professor Kayan also points out that technologists may have difficulty coming to terms, when and if the metric system is adopted.

Pure science has long been accustomed, internationally, to dealing with one specific metric system — the cgs (centimeter, gram, second) system, based on the *absolute* philosophy. People in applied science-engineering, however, have been content with the *gravitational* system. This uses, as one of its basic units, kilogram-force in the metric and pound-force in the English operation. In an effort to avoid confusion between the kilogram-mass of the absolute system and the kilogram-force of the gravitational system, Germany has introduced a special term to replace the kilogram force, the *kilopond*; it

is the legal unit there. This represents one of the controversies within the metric empire.

Growth of MKSA

According to Professor Kayan, one of the outstanding unit-systems now growing rapidly in importance throughout the world is the mksa system (meter, kilogram, second, ampere). In the world of mksa, energy, whether in mechanical or thermal form, is specified in the same terms, namely in joules or in watt-seconds. Energy-rate thus follows as watt (joule per second), or as decimal multiples thereof, such as kilowatt or megawatt. Thus, for a thermal machine doing work, there is a direct comparison (in terms of energy-flow rate or power) of kilowatt output vs. kilowatt input, representing thermal efficiency. The unit horsepower is not used. Sweden, Switzerland, Japan, Norway, USSR, and China use mksa.

Go-Metric . . . and Broke

Many members of the automobile and machine tool industry are strong opponents to conversion. A

high Ford engineering official has stated that his company "could dissipate something between 1/6 and 1/5 of the total value of the company in the conversion, and we would have accomplished nothing at the end of it."

An official of Brown and Sharpe estimates the cost of conversion "to be of a size which could well force that company out of business."

Roy P. Trowbridge, a member of the engineering staff at General Motors' Technical Center, told SAE members that design and manufacturing engineering managers within GM were of the opinion that the cost of going to the metric system is not justifiable.

Conversion by Handbook

According to Mr. Trowbridge, "it has been stated that the metric system offers greater simplicity. This is true. However, the main simplification is that of decimalization, and this can be employed in the English and U. S. systems, particularly in machine design and manufacturing, equally as well as in the metric system.

"It (the metric system) does nothing about the odd method by which we count seconds of time or degrees of arc; it provides no simplification with regard to basic physical constants such as gravitational acceleration, barometric pressure, latent heat of steam, etc. . . . The great majority of engineering and manufacturing technologists very seldom run across complicated problems of conversion. When they do, their problems are solved by reference to conversion tables in readily available handbooks.

Peaceful Coexistence?

"The motivations for going metric are quite obviously insufficient to justify conversion of our entire economy. Those segments of science, engineering and industry which can see commercial or other advantage in going to the metric system should do so by all means. However, it should not be necessary for those who do convert to feel that they must crusade for converting others upon whom conversion would place a serious handicap. The two measurement systems have co-existed for many years and they will probably continue to do so for many years to come."

DRAFTING TRENDS



This is a size comparison between the 10" POST Versalog and its 5" replica, the POST Pocket Versalog.

The trend to "COMPACT" slide rules

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That there is a need has since been proved by the thousands of engineers, architects, scientists, and students who have bought and used a Post Pocket Versalog in preference not only to the larger version, but

after comparing it with other smaller makes.

As to accuracy, we are still amazed at the exquisite job our production team has done in miniaturization—the 5" Pocket Versalog includes every one of the 23 scales found on its much larger counterpart and, in addition, bears engine-divided calibrations of such sharpness and clarity that no magnifier is needed.

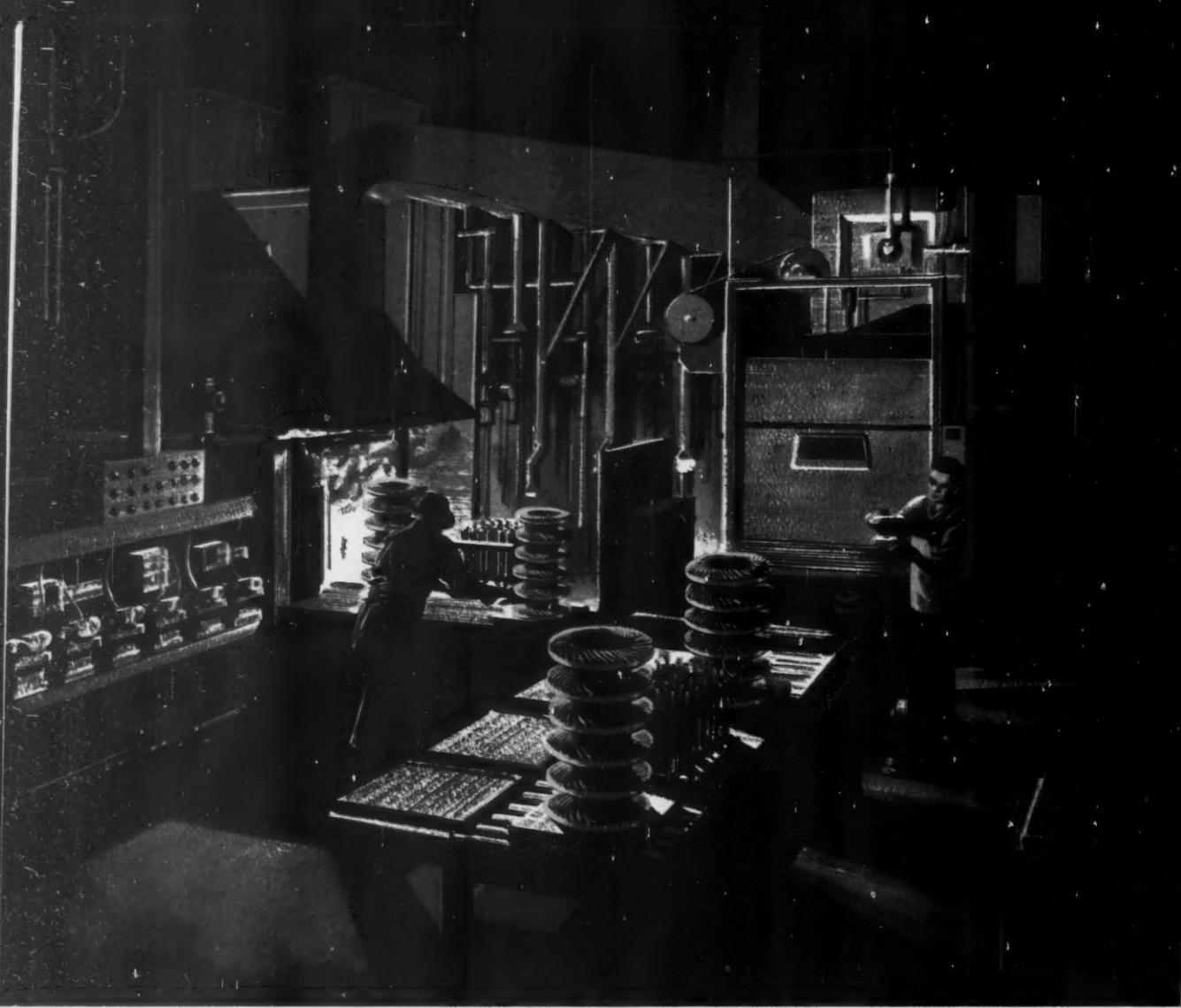
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For further information, ask your Post dealer. Or, for free literature, price data and name of nearest dealer, write to Frederick Post Company, 3652 North Avondale Avenue, Chicago 18, Illinois.



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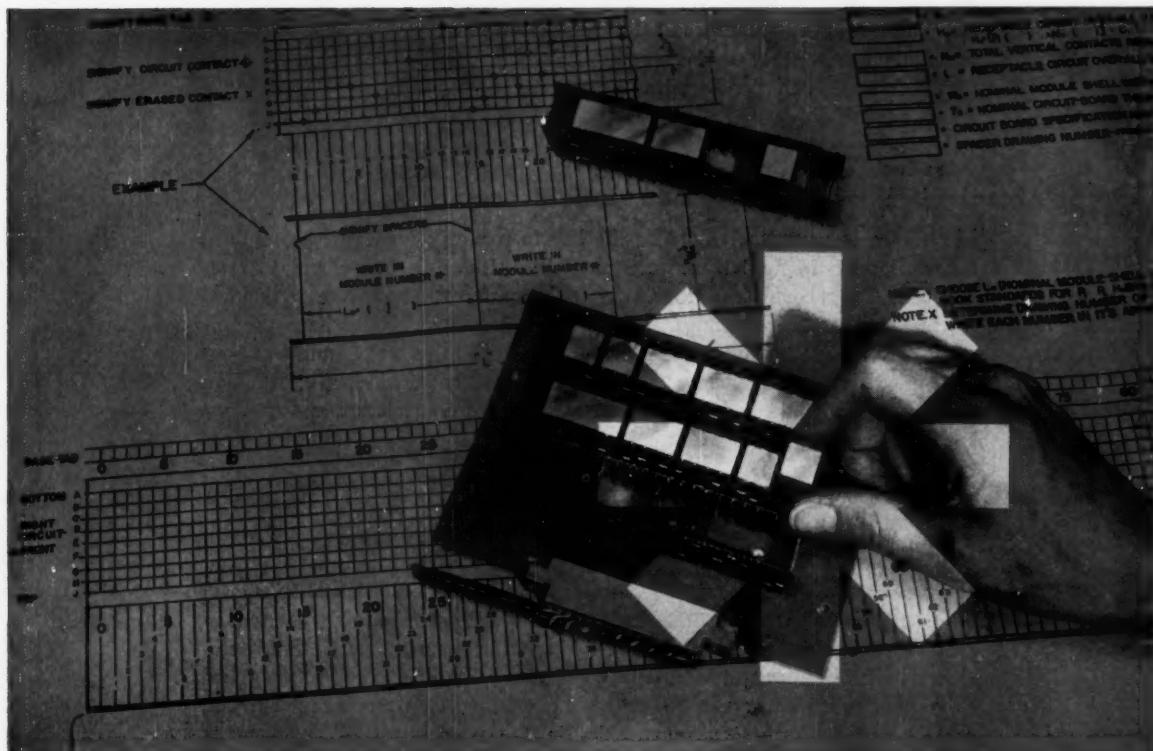
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engineering news—on the radio

Marquardt Corp., one of the prime contractors in the aerospace industry, is now broadcasting its "Engineering Report" daily over radio station WRC (Washington). Technical news and interviews with leading engineers and scientists are both included. Designed to keep engineers, scientists, and students in the area up to date, the program also acquaints the public with the scope and importance of modern technology. Washington is the third city to hear "Engineering Report." Ogden, Utah, and Los Angeles pioneered the new service.

gas turbines get a chain drive

Gas turbines in the 30 to 1800-hp range can now transmit power by chain drives. The chain, applicable to main or auxiliary powerplants, can be used to couple parallel high-speed shafts because it incorporates compensating links that fully eliminate chordal action. Developed by Morse Chain Co., the chain fills the gap between low-speed roller chain (not usable with gas turbines) and high-speed gearing.

electroluminescence—key to optical computers

Electroluminescent panels may be the key to further advances in computers, report Battelle Memorial Institute physicists Milton R. Seiler and Charles S. Peet. They could lead to design of computers that operate by optical instead of electrical couplings. An optical logic system would have the advantage of providing electrical isolation for read-in, storage, and read-out systems. Electroluminescent panels might also be used for information storage. Data could be held within a panel for several minutes and changed at microsecond switching intervals.

center for small computer jobs

Companies the size of the corner grocery store can now take advantage of electronic data processing methods. A new computer service, started in New York by National Cash Register Co., will help small firms boost efficiency by providing them with detailed pictures of their operations. Designed to handle jobs that are too limited for existing data-processing bureaus, centers will be set up in other cities in the near future. Any company equipped with an NCR adding machine and a punched-paper tape recorder will be able to use the new computer service.

more magnesium on the '64 cars?

Look for volume usage of magnesium on automotive-transmission parts within the next three years, says Robert Pittsley, Dow Chemical Co. "Magnesium's light weight and favorable economics will become major factors in the auto industry's future planning." More magnesium die castings in automotive engines and structural interior components are also expected to result. To speed things up, Dow is offering auto people three services: 1. Information on basic factors in the long-range economics of magnesium die-casting alloys. 2. Technical assistance on cost evaluations, design, and prototype testing of parts. 3. The latest know-how on techniques and processes.

needed—vacuum cleaner that works in a vacuum

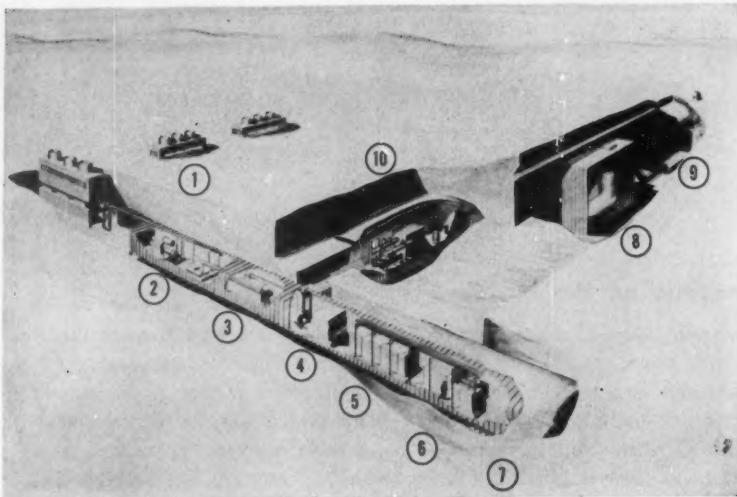
About five million tons of dust fall on the earth each year; housewives, rain, wind, and waves keep it from showing. But, according to Dr. Roy G. Breton, Aerojet-General Corp., man must design some new way to cope with the several-inch layer of "stardust" that has accumulated on the moon. A spaceship's engines could kick it up into a total-blackout dust storm; this might gum up the ship and equipment and present very treacherous footing.

three-by-five library

Newest hope in the battle against information-retrieval breakdowns is a microimage production system now being developed by Bell & Howell Co. The project involves design and development of equipment that will almost instantaneously reproduce page images on standard library-size cards. Library materials would become more accessible because literature searchers would be furnished permanent copies (cards) for immediate reading or future reference. Original reference materials would never leave the library.

work: the forgotten word

Competition, hard work, and long hours seem to be unpopular job characteristics—at least they're seldom mentioned in 135 recruiting brochures passed out to University of Michigan students. "You could read them all and never get an inkling that companies expect a good day's work," comments Dr. G. S. Odiorne, director of U-M's Bureau of Industrial Relations. "Despite emphasis on opportunities . . . there is little mention that people should expect to shoulder heavy responsibility as the price for success."



1. Air-blast coolers
2. Heat exchanger
3. Condenser
4. Turbine generator
5. Switch gear
6. Control center
7. Laboratory
8. Reactor
9. Hot-waste tank
10. Feedwater

Prefabricated reactors will soon go to work at both ends of the earth to supply

Power

FOSSIL-FUEL shortages, a chronic problem for scientists gathering data in the frozen wastelands of the world, have been licked by atomic power. Portable nuclear powerplants (portable because they can be dismantled in days and air-lifted to another location) are scheduled to take over energy-production chores. Two such plants are nearly ready: PM-2A (designed by Alco Products Inc., Schenectady) is now "critical" at Camp Century, Greenland; PM-3A (designed by Nuclear Div., Martin Co., Baltimore) will arrive at Antarctica's McMurdo Sound this year.

Heat from these reactors will keep powerplant buildings warm, melt snow for water supplies, and generate electricity for radio communications, heating, lighting, and even cooking.

The Armed Forces estimate that transportation of conventional fuels represents 70-80 per cent of the supply effort for arctic installations. At sites supported

by parachute drops, delivered cost of diesel fuel can exceed \$2.50 per gal.

The Camp Century reactor will operate for an entire year on a single loading of nuclear fuel (shipped in eleven steel drums with an equivalent 55-gal capacity). A conventional powerplant of the same output would require 850,000 gal of diesel oil. Studies indicate that the fuel savings alone will pay for the initial cost of the nuclear plant in a few years, and that millions of dollars will be saved during the reactor's life.

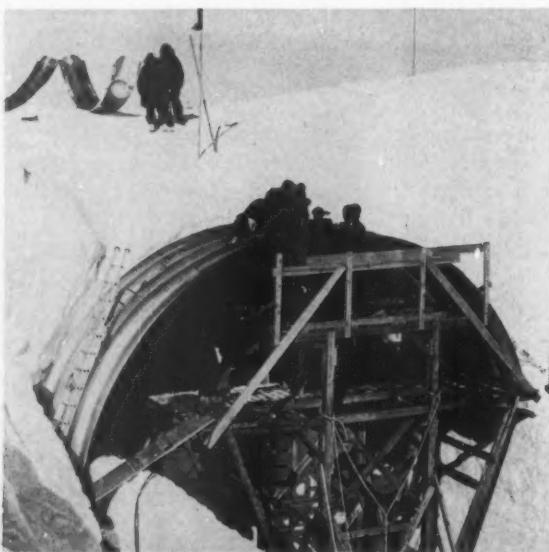
Second argument for nuclear power hinges around safety. Oil-fired cookers and heaters have always been a special threat where subzero temperatures make normal fire-fighting procedures impossible and where the loss of a shelter can mean quick death.

Assembly in the Summer

Portability is one of the primary requirements for remote-area powerplants. Labor and transportation costs greatly exceed those in the U. S., and construction is hampered by short summers.

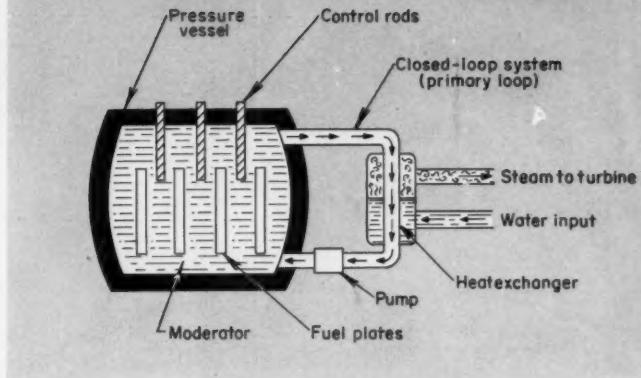
Portable nuclear powerplants are designed for shipment in aircraft. Skid-mounted modules meet size and weight limitations of the standard military cargo planes (C-130 class or larger). Maximum weight of a single loaded skid is 15 tons; maximum size is 28 ft long by 9 ft high by 8 ft, 7 in. wide.

Extensive effort has gone into development of the



Designed to house a reactor, this modern igloo was dug out of a Greenland ice cap. After special plows completed the trench, corrugated-steel roofing closed it in. To complete the job, snow was pushed over the roof. When the reactor operates, cold air is circulated in the tunnel to keep the walls and floor from melting.

Pressurized-water reactors were picked for polar service because they are the most advanced nuclear powerplants available. While several other types show promise, design data are still too scanty. In the PWR, the moderator, pressurized hot water, is heated by the chain reaction in a closed-loop system. Pumped through a heat exchanger, the water produces steam that drives a turbine. Army designations for the polar reactors (PM-2A, PM-3A) tips off their portability (P), medium-power range (M), and purpose (A—to operate as on-line power generators, rather than as prototypes for later models).



	Camp Century	McMurdo Sound
Designation	PM-2A	PM-3A
Designer	Alco	Martin
Gross Output (megawatts)	10	10
Net Output: Heat (10^6 Btu/hr)	10	6.5
Electric (kw)	1560	1500
Primary-loop pressure (psia)	1750	1300
Primary-loop temperature (F)	518	463

at the Poles

modular, prepackaged, and pretested subsections that hook together with quick-connect cables and flanged-pipe joints. The Alco version, transported in 27 packages, was installed in snow tunnels in six weeks. Two years would be the normal construction time for the same size nonportable plant in the U. S. The Martin plant, to be shipped in 18 modules, will be installed within 60 days of delivery.

Design for air shipment presents more than just package-size headaches. Centers of gravity must be carefully located, and resistance to g loadings must be high. For transport in the C-130A aircraft, limit-loading requirements are 3 g fore and aft, vertical and downward; 1½ g laterally.

All-important Reliability

Operated far from civilization, the reactors must furnish continuous power. Reliable equipment is essential to life in the polar regions. Strict design criteria govern allowable down time, refueling time, core life,

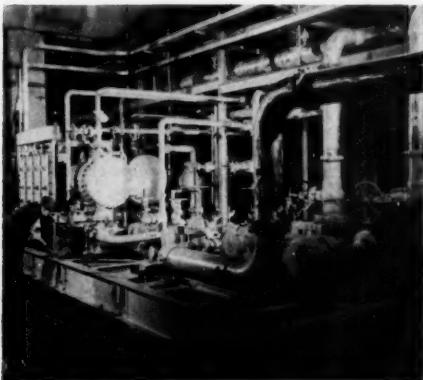
etc. In addition, the plants have diesel emergency-power systems to provide heat and power during maintenance periods (not to exceed 21 days per year).

Failure-prone parts are built into the plant in duplicate, providing ready-to-go spares. Parts that are not duplicated are designed so they can be replaced quickly with special-purpose tools.

Waste heat produced by the nuclear powerplants must be rejected to the atmosphere—there's not enough cooling water available at the sites. Ambient temperatures are so low that freeze-up problems can result.

The Greenland plant incorporates a two-stage heating-rejection system. A solution of ethylene glycol in water acts as an intermediate condensing fluid; final cooling takes place in glycol-to-air heat exchanger.

Not all cold-weather problems have to do with freeze ups, however. The Greenland reactor is housed underground in snow trenches that are roofed with corrugated steel. Cold air must be constantly circulated in these trenches to keep heat from melting the walls.



Heat-exchange equipment, mounted on this skid, will reheat water from the condenser of Alco's Camp-Century reactor. Twenty-seven skid-mounted modules makeup the Greenland system; the McMurdo Sound equipment will be shipped in 18 packages. To demonstrate the portability concept, Martin Co. loaded one of the 15-ton test packages into this C-130A aircraft last year.





An estimated 300 parts in the various '61 cars are made of plastic. Selection above, made of Dow Chemical's Styron 440 (high-impact polystyrene) is typical of the functional and decorative applications now in use. One-piece, snap-in automobile ceiling (right) is being used by American Motors. The headliner is molded of Fiberglas fabric (Owens-Corning) laminated to glass-fiber insulation. According to AM, the top cuts road noises by 30 per cent, provides excellent thermal insulation, and gives $1/2$ in. additional headroom.



Plastics Gain in

Variety, Size of Parts

TWO problems continually facing automotive engineers—the need for reducing vehicle weight and for further automation in production—may soon be solved by plastics. This was the opinion of a group of engineers speaking before the SAE International Congress and Exposition in Detroit.

R. T. Stevens, I. J. Gusman, and I. B. Cohen of J. P. Stevens & Co., New York, pointed out that although the auto industry has been a recognized leader on the road to mechanization, it has been partially stymied in one particular area. The recurrent demands of styling obsolescence have prevented any major breakthrough in reducing the amount of hand labor in body assembly.

They predict that the problem will be short lived, however, and that large one-piece moldings of high-strength, low-density plastic will be the answer.

As part of what Messrs. Stevens, Gusman, and Cohen term functional integration, simplified monocoque or shell-type constructions will be made with little or no separate framing. Strength and rigidity will be molded in, not added as extra framing, stiffeners, or gussets. The automobile roof and headliner will be one piece, interior trim and styling will be part of the body shell. The trunk, gas tank, and spare-tire well conceivably can be produced as a single molding. The floor pan can be combined with the covering material, and the instrument panel, fire wall, and plenum chamber will also be molded as one piece. Where acoustical and thermal insulation is needed, polyether-base urethane foams will be sprayed onto the plastic shell and become

Bits and Pieces . . .

Introduction of plastics to the automobile industry has involved small parts and piecemeal substitutions . . . a sort of familiarization course for the engineers involved. Heating and air-conditioning ducts, instrument clusters, convertible tops (Ford's first T-Birds), and the snap-in headliner used in '61 American Motors cars are typical application examples. During this get-acquainted period, there has been strong adherence to the design techniques, engineering principles, and manufacturing methods used in making metal parts.

the Auto Race

Are Increasing Rapidly

an integral part of it. Doors will be of sandwich construction, with decorative plastic facings, honeycomb in between.

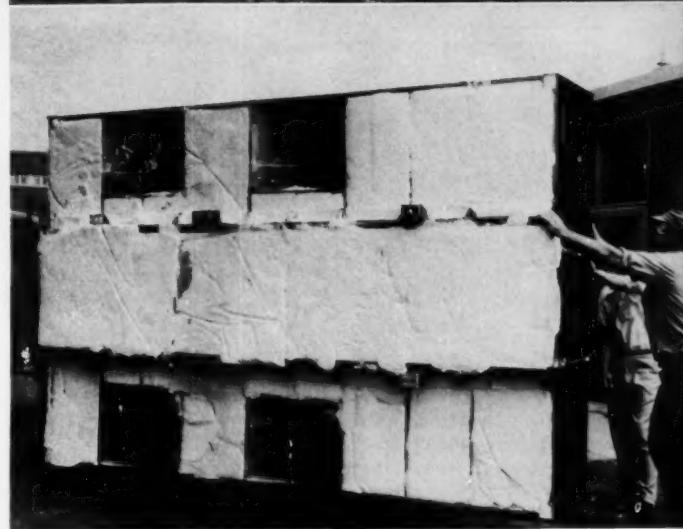
The effects of reinforced plastics on tooling costs and tooling flexibility in body manufacturing are exceedingly attractive. Expensive hard-faced dies, massive presses, and high forming pressures are not required.

Continually researching new modes of transportation, the auto industry is now studying ground-effect machines, unicycle vehicles, amphibian and triphibian cars. More than likely, the shapes of the future will require high-strength, light-weight materials suitable for constructing shell-like frameless structures. This is particularly true of proposed multipurpose vehicles, which will face unusually severe weather, corrosion, and surface-durability problems.

Although present plastics seem able to solve most of the future problems, by the time the exotic vehicles become a reality, further advances will be made in plastics technology. A forerunner of future high-performance reinforced plastic materials is already on its way from the research laboratory, according to Messrs. Stevens, Gusman, and Cohen. The material is a high-modulus glass fiber containing 8 per cent beryllium oxide. The new formulation results in glass fibers having 50 per cent higher modulus of elasticity than do the present fibers used in reinforcing. When the beryllium-oxide glass is imbedded in the plastic matrices, it provides impressive improvements in rigidity, without sacrificing strength. Along with the new material, significant improvements in glass-fiber forming techniques are expected.

... Paved the Way

According to Messrs. Stevens, Gusman, and Cohen, body engineers are only now beginning to exploit the full advantages of reinforced plastics. Truck cabs produced by Heil, Brockway, and White are dramatic examples of the advancing state of the art. The truckers' incentive may well have come from the opposite end of the vehicle spectrum: A bright, shiny 1954 Chevrolet Corvette, on display at the SAE Exposition, showed no body deterioration although it had logged 150,000 miles under all types of weather and road conditions.



Foam-filled cargo bed in one of Army's experimental 3 1/2-ton trucks (above) makes the vehicle virtually unsinkable. Truck is under development at Reo Div., White Motor Co. Another, similar vehicle being tested by the Army also uses foam for flotation. Fabricated almost entirely of aluminum - honeycomb sandwich, it will swim with 5 tons of payload. Station wagon (left) is also a panel truck and pickup truck, depending on which of three interchangeable plastic tops is used. Owens-Corning thinks the concept is feasible, largely because of low tooling costs for glass-fiber reinforced plastics.

This Snowblast can pick up snow—whether freshly fallen, packed down, or slushy—and toss it across a four-lane highway. Helical blades, rotating at a surface speed of up to 50 fpm, provide plowing rates up to 30 mph. The blades shear snow from the mass to be removed, accelerate it in a nonturbulent flow to a large impeller housing opening; impeller blades accelerate it further so that it is discharged at speeds up to 103 fps. Builder of this "two-stage snow pump" is American Snowblast Corp.

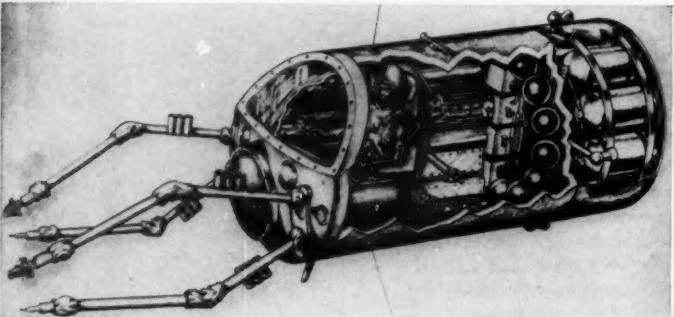
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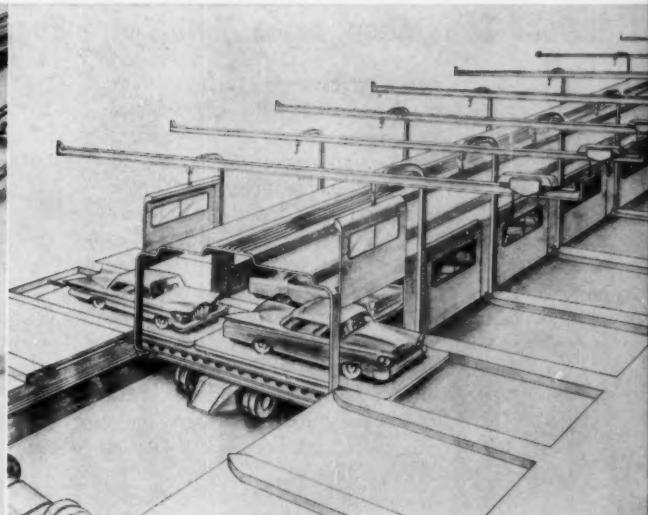
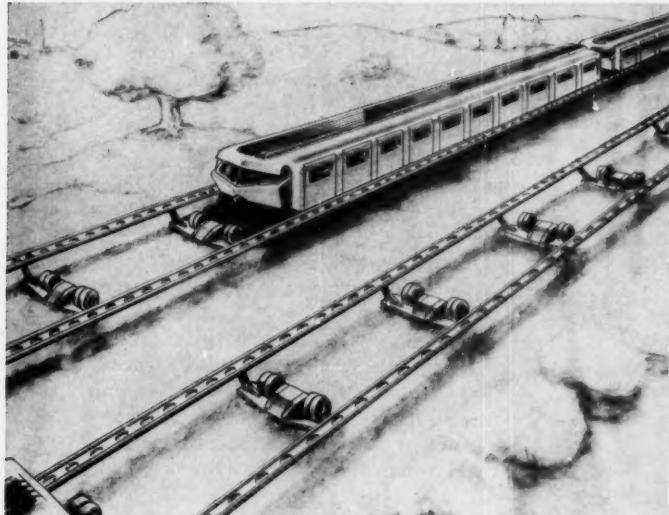
Radar for small boats features an illuminated azimuth ring encircling the scope, for visibility at night. Radar 5B, developed by Sperry Piedmont Co., Charlottesville, Va., has one-mile and five-mile range scales. It weighs only 40 lb and operates from either 12 or 32-v battery power supplies. The system's antenna unit contains both transmitter and receiver.



The recently launched Blue Scout I, a three-stage, solid-propellant rocket, carried instruments to measure eight different types of environmental conditions in space. Built by the Aeronutronic Div. of Ford Motor Co., this Blue Scout is the first guided version to be launched in a new Air Force program.



A multi-handed construction worker such as this "space tug" may assemble space stations in orbit. Assuming that a man's mobility and access to tools will be limited, the Martin Co. is studying the possibilities of a manned capsule, equipped with power tools and remotely controlled manipulators. The four-ton tug would contain a computer, autopilot to prevent tumbling, reactor motor for maneuvering, and two days' supplies for the operator.



Averaging 120 mph, automobiles and passengers could travel safely and efficiently on Roller Roads, says Westinghouse Electric Corp. The proposed roadway would consist of supporting and propelling rubber rollers, spaced about 20 ft apart and powered

by individual electric motors. Drive package for each roller consists of a three-phase induction motor, a torque converter, a brake, and a reduction gear. Loading and unloading of automobiles and dispatching of carriers would be computer-controlled.

Carat-size—and larger—diamonds from the lab are announced by General Electric Co. Although a thousand times bigger than the first man-made diamonds (produced by GE in 1955), the new industrial gems are not yet better. In fact, structural imperfections deprive them of sufficient mechanical strength for industrial applications. The company doesn't predict when usable diamonds this size will be available; however, 1/10-carat stones "of excellent industrial quality" have been produced.



Styling, Suspension Distinguish New Trucks and Wagons



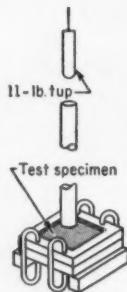
Lower, longer-wheelbase light-duty vehicles by International Harvester feature torsion-bar and I-beam front-end suspensions, welded box-section and channel-steel frames, and a variety of body styles. The Travelette, left, combines a six-passenger cab with pickup body; the Travelall station wagon

carries nine passengers or 124 cu ft of cargo. Both are available with four-wheel as well as two-wheel drive. A 155-hp V-8 engine is standard on all the new C-line vehicles; also available are a 193-hp V-8 and three valve-in-head six-cylinder engines, one with an Ipg fuel system.

Dent Tests Show Light Metals Are Rugged

DENT resistance gives a fair criterion for estimating how well thin sheet-metal structures—from lunch boxes to computer housings—will stand up under the wear and tear of everyday service. To give designers a quantitative notion on this “resistance-to-battering” property, Dow Metal Products Co. (Div. of Dow Chemical) has reported results of a series of tests on the dent resistance of sheet aluminum and magnesium alloys. For comparison, Dow checked samples of mild-steel sheet. Two interesting conclusions, based on data like that plotted below, were reported by Dow:

- On an equal-thickness basis, all three metals (mild steel, aluminum, and magnesium) exhibited about the same resistance to denting.
- On an equal-weight basis, the magnesium and alu-

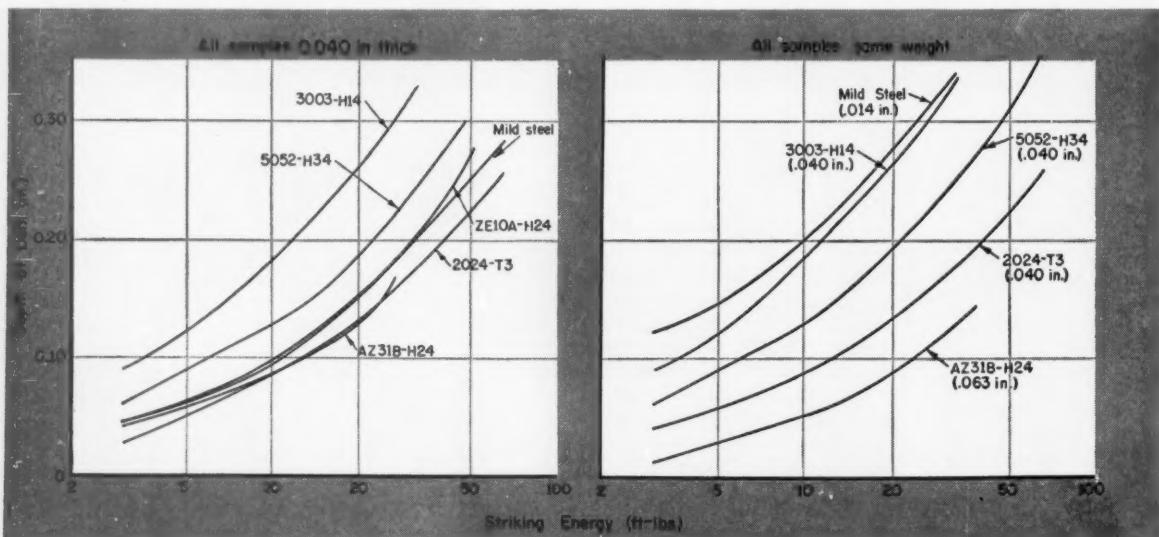


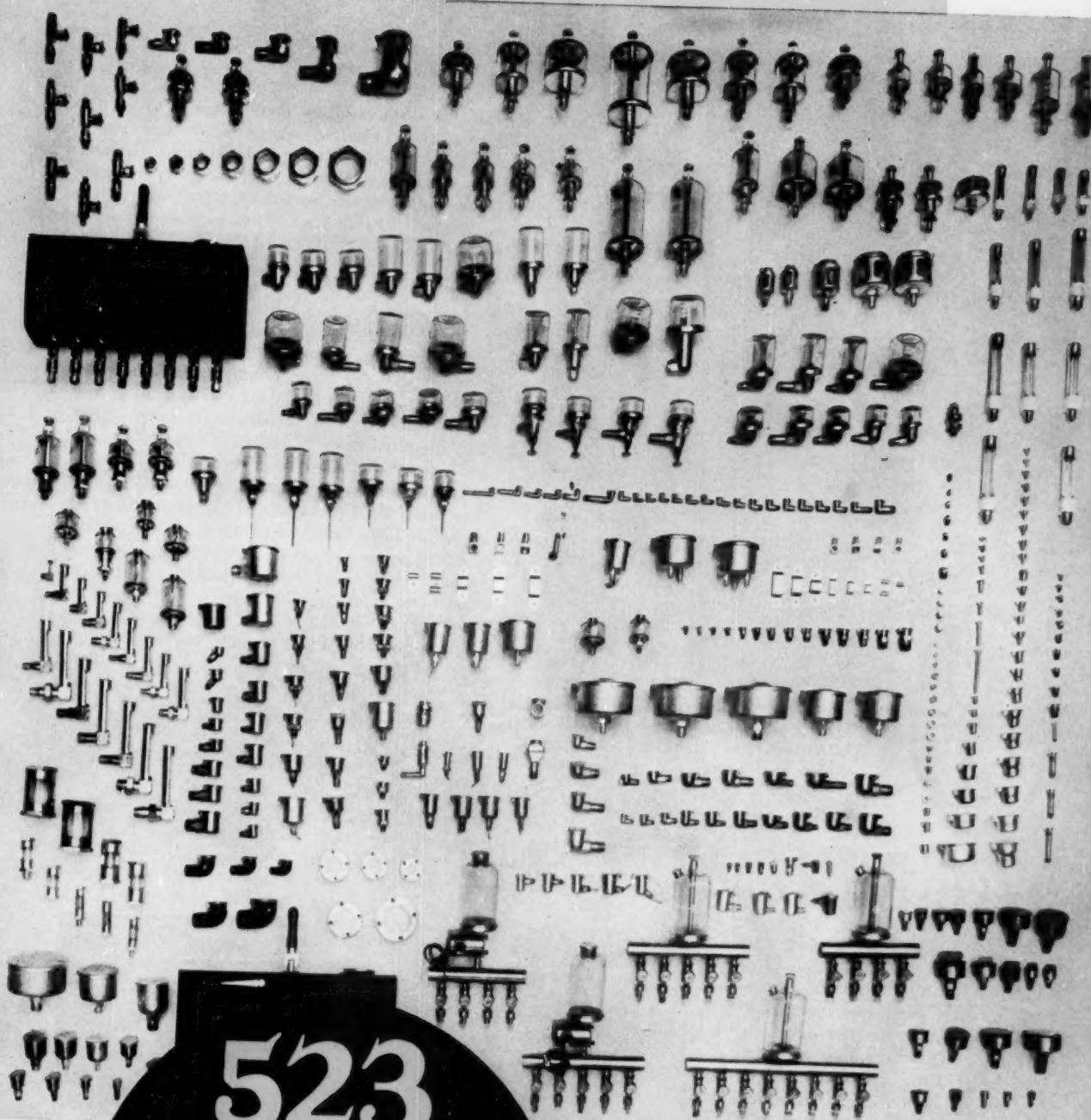
minimum alloys are superior to mild steel.

In all tests, depth of the dent was taken as the difference in elevation from the center of the dent to a 3-in. surrounding circle.

Apparatus used in the tests (sketch, left) consisted of a picture-frame arrangement to hold the sheet specimen, an 11-lb tup with the end machined to a 2-in. diam hemisphere, and a pipe through which the tup was dropped from various heights.

Sheet specimens were cut into 18-in. squares and placed in the frame. Bolt heads, extending along two sides of the frame, pushed the sheet into matching grooves on the other half of the frame when the assembly was drawn up with C clamps. No slippage could be measured when the sheet was struck by the falling tup.

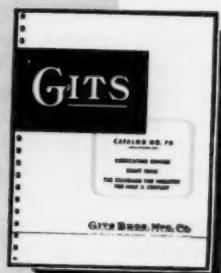




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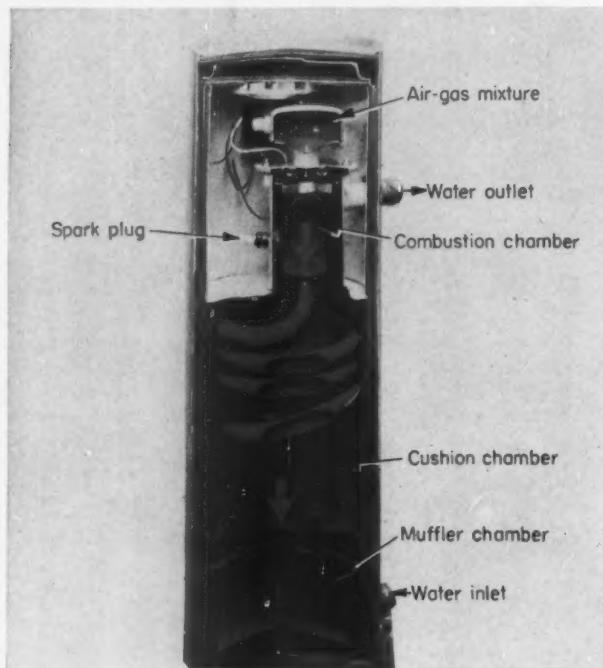
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Circle 414 on Page 19

Prosaic Job for a Pulse-Jet Descendent



Spark plug ignites first slug of gas; shock waves ignite those that follow. The unit is exceptionally safe because little fuel is present in the combustion chamber at any time.

TORONTO—Staccato-like detonations of fuel gas furnish water-heating energy in a new boiler developed by Lucas-Rotax Ltd., Toronto, Canada. The combustion system, first peace-time design successfully adapted from the German V-1 pulse-jet engine, fires 70 times each second. Pressure waves are set up that open and close valves, ignite up-stream slugs of gas, propel combustion products toward a vent, and scour the heat-exchanger walls.

Claimed to be smaller and safer than other boilers, the unit's prime advantage is higher efficiency (90 per cent or more). Because pressure waves "clean off" boundary-layer films, the heat-transfer coefficient is almost ten times higher than in other units. Flue temperatures average 140 F or less (compared to about 400 F for conventional water heaters), and the cold flue causes an additional boost in efficiency: Exhaust gases are below dew-point temperature. Water vapor, produced by combustion and present in excess air flowing through the unit, condenses out of the exhaust-gas mixture. For every pound of water condensed, 1000 Btu of heat are liberated.

Noise resulting from pressure waves and detonation of the gas is eliminated by mufflers at inlet and outlet ends of the heater. Although the unit contains noise mufflers and other kinds of unconventional equipment, L-R engineers have reduced size to half that of contemporary water heaters.

Quick Check for the Continental

DETROIT — Electrical systems and components on the '61 Lincoln Continentals must all pass the "Eager test." Eager, electronic audit gager, is a quality-control device developed for Ford by Performance Measurement Co.

Housed in a 6-ft portable cabinet, the instrument checks out cars coming off the final assembly line. A technician, sitting in the car, operates a remote-control device to activate a 35-mm film strip and a bank of photocells in the machine. Test instructions are flashed on a teleprompter-like screen. A light beam from the projector passes through a dot pattern on the film to energize the photocells, informing the equipment what test is to be run, time delay, voltage range, etc.

Once the technician selects and starts a test, acceptance limits and meter readings are projected on the screen for his evaluation.



Up to 339 electrical components on the Continental can be checked by Eager, Ford's new quality-control machine. Test cycles can be completed as fast as buttons can be pressed and data read.

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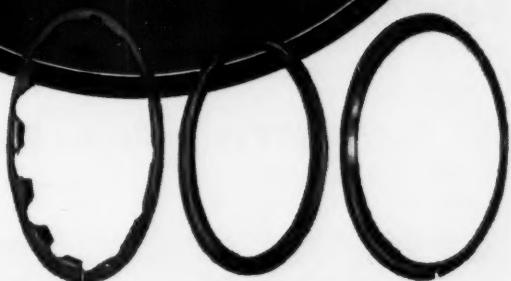
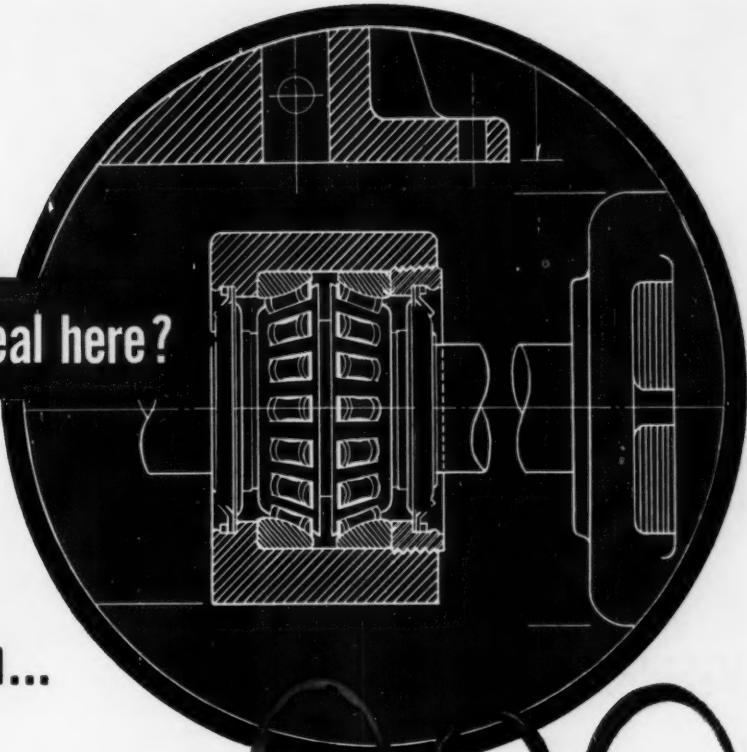
FOR MOST CONDITIONS, the Shafer "Z" Seal, the industry's only all-metal, fully self-aligning seal: self-aligning for positive sealing despite as much as 3° total shaft deflection; all-metal for maximum wear life.

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FOR HIGH SPEEDS, SEVERE VIBRATION, the "K" seal is a light contact seal of neoprene/felt-neoprene construction enclosed in a metal casing. Self-aligning for positive sealing despite 3° misalignment.

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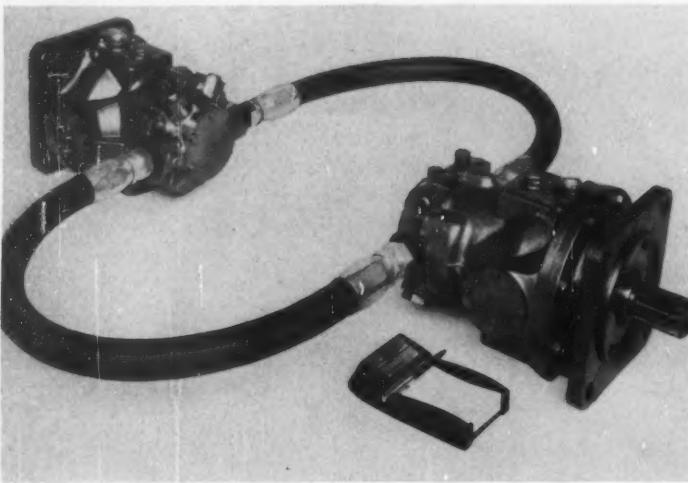


SHAFER-REX "K" SEAL

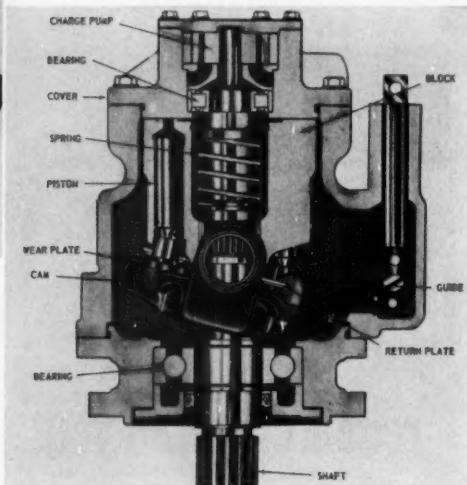


SHAFER-REX "M" SEAL

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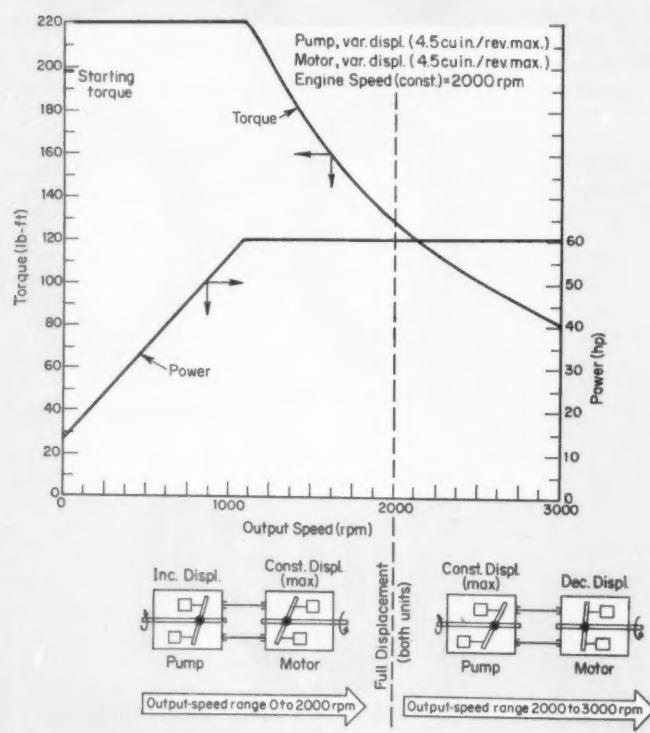


Uncluttered driveline is offered by the hydrostatic transmission: Conventional gearbox, clutch, driveshaft, and universals are replaced by flexible hydraulic lines connecting the compact pump and motor (cutaway below).



Hydrostatic Drive Favors Vehicle, Designer, Operator

All-Oil Transmission Now in Production



WATERTOWN, N. Y.—After long tenure as a dark horse in the fluid-drive field, the hydrostatic transmission may soon see service in a variety of off-road vehicles. One of the latest, now in production at Watertown Div., New York Air Brake Co., claims to be free of the problems (including high cost) that have held back the acceptance of earlier models.

In its simplest form—installed in a fork lift truck, for example—New York Air Brake's Dynapower transmission consists of a variable-displacement, axial-piston hydraulic pump coupled to the vehicle's engine, and a fixed-displacement hydraulic motor which drives directly into the differential. Other combinations of single and dual, fixed and variable pumps and motors are feasible for applications having different performance requirements.

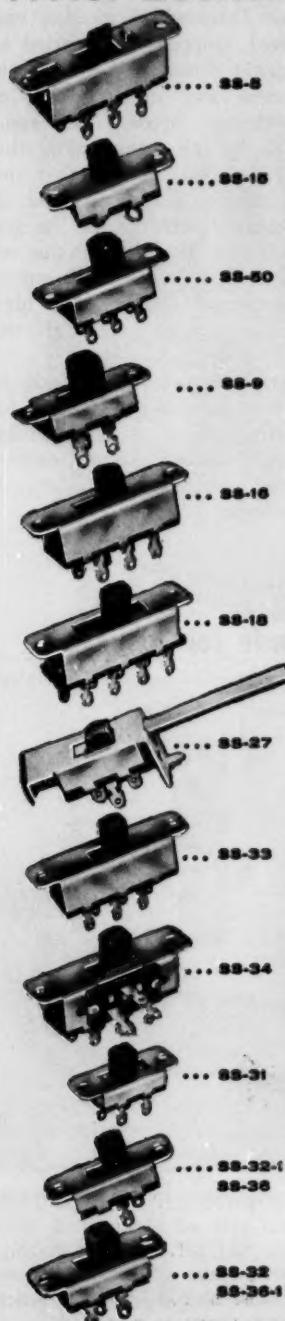
Operation of the transmission is

Unusually flexible hydrostatic-drive system results when both pump and motor are variable-displacement types (performance plot, left).

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MEDIUM-DUTY TYPES					
SS-5	DP-DT Spring-Return, No detent			0.5	0.5
SS-15	SP-ST Pushbutton, Momentary, No detent			1.0	—
SS-32	SP-DT Maintained, With detent			1.0	1.0
SS-32-1	SP-ST Maintained, With detent			1.0	1.0
SS-50	DP-DT Maintained, With detent			0.5	0.5
3 - AMPERE TYPES					
SS-9	SP-DT Spring-Return, No detent			3.0	0.75
SS-16	3-POSITION Maintained, With detent			3.0	0.5
SS-18	4-POSITION Maintained, With detent			3.0	0.5
SS-27	SP-DT Spring-Return Plunger, No detent			3.0	0.75
SS-33	DP-DT Maintained, With detent			3.0	0.5
SS-34	TP-DT Maintained, With detent			3.0	0.1
6 - AMPERE TYPES					
SS-31	3-POSITION Maintained, With detent			6.0	1.0
SS-36	SP-ST Maintained, With detent			6.0	1.0
SS-36-1	SP-DT Maintained, With detent			6.0	1.0

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A manufacturer of RF connectors was machining contact fingers from Beryllium-copper bar stock on automatic screw machines. This required turning to exact O.D. and drilling to specified I.D. Nature of the material required constant sharpening of cutting tools.

Parts half done to start

Then they switched to Uniform Beryllium-Copper Tubing, drawn to precision I.D. and O.D. specifications—and the "parts were half done to start." Twenty seconds per piece were saved in actual fabrication time, plus the time formerly required for excessive tool maintenance and machine downtime for their replacement.

The Beryllium-copper tubing, costing about 15% less than the bar stock, added further economy to overall part production.

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Uniform's fine, seamless tubing is available in many alloys of aluminum, copper, nickel, steel and the precious metals. Sizes range from .010" to .625" O.D. Wall thicknesses down to .001 (.0005 on special order). Tolerances down to .00025.

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Circle 417 on Page 19

cause there is no increase in wheel speed even if the operator does break traction.

Replacement of the conventional drive train by hydraulic lines—which can be placed anywhere—opens the door to new vehicle-design ideas: The engine can be mounted at any angle, in any location; frame design does not have to include a drive tunnel.

Reversing vehicle direction with the hydrostatic transmission illustrates another one of its desirable features: Drive-wheel rotation can be slowed, stopped, and started in the opposite direction with absolute smoothness and at any rate of change desired. Accomplished automatically by the transmission, this smooth reversal means that no abrupt shocks are transmitted to the wheels, differential (if the system calls for one), or to the vehicle's engine. Even an inexperienced operator doesn't send high shock loads racking through the vehicle.

Dynapower transmissions now in production have been designed for the traction-drive in lift trucks, front-end loaders, farm tractors, combines, and other similar off-road vehicles.

Gas Turbine Tractor Tests Aptitude for Army



One of the first military applications of turbine-powered earthmoving and construction equipment is in a Caterpillar tractor being tested at the U. S. Army Engineer Research and Development Laboratories, Fort Belvoir, Va. The gas-turbine engine, developed by General Motors Corp., has a maximum 206-hp rating; the tractor's original diesel engine was rated at 200 hp. Modified to accommodate the gas-turbine powerplant, the tractor serves as a testbed.



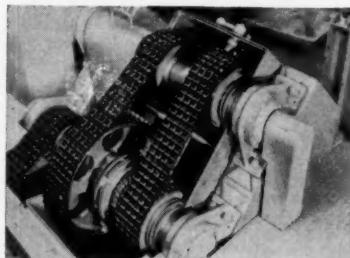
Here's
another of the
invisible extras that
insure the precision performance
of LINK-BELT roller chain



prestressing of multiple-strand chain guarantees uniform load distribution

Unless each strand carries its full share of the load, multiple-strand roller chain may fail. That's why Link-Belt's prestressing is so vital. Prestressing seats and cold-works the chain joint parts . . . assures equal load distribution across the chain, reduced elongation in service.

Prestressing is just one of many *invisible extras* that contribute to the greater strength and endurance of Link-Belt roller chain. Others include precise heat-treat control, pitch-hole



Quadruple-strand Link-Belt roller chain drives are used on this two-speed transmission. High speeds on short centers are easily handled.

preparation, shot-peening and burnishing of rollers. These features—plus painstaking precision and inspection in every step of manufacture—assure you of chain that can easily cope with today's heavy loads and high speeds.

For engineering assistance in applying industry's preferred roller chain, contact your nearest Link-Belt office. Look under chains in the yellow pages of your local telephone directory. Ask for Book 2657.

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Rugged protection with rigid acetate plastic protectors

Try this sometime. Put an S. S. White Quality Line rigid acetate cap (free samples available) on a threaded part and whack the daylights out of it. You'll be surprised when you see how the threaded part comes through undamaged!

Here is the ultimate in protection against impact for your quality products. Rugged, *positive* protection against damage, dirt, fluids... during processing, storage, shipping.

Investigate, also, our **Economy Line** of elastic vinyl protectors; low cost...easy on, easy off, yet a stay-put fit...absolutely non-shredding.

Remember for only a few pennies you can protect vital equipment and your customer's good will!

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P-5708 and Free Samples

1143

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**PLASTICS
DIVISION**

Dept. 4P, 10 East 40th Street, New York 16, N.Y.



ENGINEERING NEWS

Meetings and Shows

Feb. 13-16—

American Society of Heating, Refrigerating and Air-Conditioning Engineers. National Meeting and 15th International Heating & Air-Conditioning Exposition to be held at the International Amphitheatre, Chicago. Additional information can be obtained from exposition headquarters, 480 Lexington Ave., New York 17, N.Y.

Feb. 26-March 1—

First Pacific Electronic Trade Show to be held in the Great Western Exhibit Center, Los Angeles. Additional information can be obtained from PETS headquarters, 2216 South Hill St., Los Angeles 7, Calif.

March 5-9—

American Society of Mechanical Engineers. Gas Turbine Power Conference and Exhibit to be held at the Shoreham Hotel, Washington, D. C. Co-sponsor is the U. S. Dept. of Defense. Further information can be obtained from ASME Meetings Dept., 29 W. 39th St., New York 18, N.Y.

March 8-10—

Instrument Society of America. Annual Conference on Instrumentation for the Iron and Steel Industry to be held at the Roosevelt Hotel, Pittsburgh. Further information can be obtained from Richard R. Webster, Jones & Laughlin Steel Corp., Research Laboratory, 900 Agnew Ave., Pittsburgh 30, Pa.

March 11-14—

Steel Founders' Society of America. Annual Meeting to be held at the Drake Hotel, Chicago. Further information is available from society headquarters, 606 Terminal Tower, Cleveland 13, Ohio.

March 12-16—

American Society of Mechanical Engineers. Aviation Conference to be held at the Statler Hilton Hotel, Los Angeles. Additional information

tion is available from ASME Meetings Dept., 29 W. 39th St., New York 18, N. Y.

March 13-17—

National Association of Corrosion Engineers. Annual Conference to be held at the Statler Hotel, Buffalo. Additional information can be obtained from NACE headquarters, 1016 M & M Bldg., Houston 2, Tex.

March 13-17—

Society of Automotive Engineers Inc. National Automobile and Production Meetings to be held at the Sheraton - Cadillac Hotel, Detroit. Further information can be obtained from SAE headquarters, 485 Lexington Ave., New York 17, N. Y.

March 16-17—

American Society of Mechanical Engineers. Textile Engineering Conference to be held at Clemson College, Clemson, S. C. Additional information can be obtained from ASME Meetings Dept., 29 W. 39th St., New York 18, N. Y.

March 20-23—

Institute of Radio Engineers. International Convention to be held at the Coliseum and the Waldorf-Astoria Hotel, New York. Additional information is available from IRE, 1 E. 79th St., New York 21, N. Y.

March 20-24—

American Society for Metals. Thirteenth Western Metal Exposition & Congress to be held at the Pan Pacific Auditorium, Los Angeles. Additional information can be obtained from ASM, Metals Park, Novelty, Ohio.

March 21-23—

American Power Conference to be held at the Sherman Hotel, Chicago. Sponsors are nine engineering societies, including American Society of Mechanical Engineers, National Association of Power Engineers, American Institute of Electrical Engineers, American Society of Civil Engineers, and American Society of Heating, Refrigeration, and Air Conditioning Engineers; Illinois Institute of Technology and

(Please turn to Page 42)



Send for Catalog 75 and/or Stock List including new patterns



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NEWS! ONLY V-BELTS BY GOODYEAR

to give you sets matched in length to pull together

What's more, Green Seal V-Belts give you—

True dimensional stability for the life of the belt—built in through the use of shrink- and stretch-resistant 3-T Process Cord or airplane-type steel cable.

Mildew-inhibited construction for protection in damp operating conditions.

Widest selection from the most complete V-belt line anywhere.

Ready availability from distributor stocks in every part of the country.

Technical assistance whenever it's needed from a qualified expert, the G.T.M.—Goodyear Technical Man.

For the best buy in V-belts call your Goodyear Distributor. Or write Goodyear, Industrial Products Division, Akron 16, Ohio.



**Lots of good things
come from**

GOOD



MACHINE DESIGN

GREEN SEAL ARE CODED TO 1/32"...

perfectly for longer, more trouble-free service



LENGTH-CODING GREEN SEAL V-BELTS TO 1/32"—NOT JUST 1/10", LIKE MOST BELTS—takes this ultra-precision machine. Only Goodyear has this type equipment, which is set by means of fine tolerance steel templates to insure accuracy. Machine readings are in the actual code numbers used to eliminate errors.

Green Seal—T.M. The Goodyear Tire & Rubber Company, Akron, Ohio

YEAR

INDUSTRIAL PRODUCTS

Why Die Stamped Circuits by Dytronics?

EXACT CIRCUIT DUPLICATION

... 25,000 or 5,000,000 units

One of the major problems in printed circuitry is exact duplication of the circuit pattern from unit to unit. The Dytronics die stamped process eliminates this headache by utilizing a metal-cutting die to delineate the conductor pattern exactly whether 25,000 or 5,000,000 circuits are produced.

A new booklet, "Designing with Dytronics Die Stamped Circuits," gives other important reasons for specifying these quality circuits and provides information that will help you design them. Write for a free copy.



Dytronics
INCORPORATED

ROCHESTER 47, MICH.

A subsidiary of Taylor Fibre Co.,
Norristown, Pa.

Circle 422 on Page 19

ENGINEERING NEWS

(Continued from Page 39)

13 other universities. Additional information can be obtained from R. A. Budenholzer, Illinois Institute of Technology, 35 W. 33rd St., Chicago 16, Ill.

April 4-6—

National Microfilm Association. Tenth Annual Meeting and Convention to be held at the Sherman Hotel, Chicago. Additional information can be obtained from the association's executive secretary, Vernon D. Tate, P. O. Box 386, Annapolis, Md.

April 4-7—

Society of Automotive Engineers Inc. National Aeronautic Meeting, including production forum and display, to be held at the Hotel Commodore, New York. Further information is available from SAE headquarters, 485 Lexington Ave., New York 17, N. Y.

April 6-7—

American Society of Mechanical Engineers-Society for the Advancement of Management. Management Engineering Conference to be held at the Statler Hilton Hotel, New York. Further information can be obtained from ASME Meetings Dept., 29 W. 39th St., New York 18, N. Y.

April 10-21—

American Welding Society. 42nd Annual Convention and Welding Exposition to be held at the Coliseum, New York. AWS will also act as host to the International Institute of Welding, which meets at the Sheraton-Atlantic Hotel. Technical meetings of AWS will be held at the Commodore Hotel as well as the Coliseum. Additional information is available from society headquarters, 33 W. 39th St., New York 18, N. Y.

Short Courses and Symposia

Feb. 22-23—

Seminar on Automation and Numerical Control, sponsored by the American Society of Tool and Man-

ufacturing Engineers, to be held at the Bond Hotel, Hartford, Conn. Additional information is available from ASTME, 10700 Puritan Ave., Detroit 38, Mich.

March 20-31—

Industrial Packaging Short Course to be held at Purdue University. Additional information is available from Mark E. Ocker, Conference Co-ordinator, Div. of Adult Education, Memorial Center, Purdue University, Lafayette, Ind.

March 27-31—

Third Symposium on Temperature—Its Measurement and Control in Science and Industry to be held at Veterans Memorial Auditorium, Columbus, Ohio. Sponsors are Instrument Society of America, American Institute of Physics, and National Bureau of Standards. Further information is available from ISA, 313 Sixth Ave., Pittsburgh 22, Pa.

March 28—

17th Annual Quality Control Clinic to be held at the University of Rochester, Rochester, N. Y. Sponsor is the Rochester Society for Quality Control. Further information can be obtained from Albert D. Rickmers, Associate Professor, College of Graphic Arts and Photography, School of Photography, Rochester Institute of Technology, 65 Plymouth Ave. South, Rochester 8, N. Y.

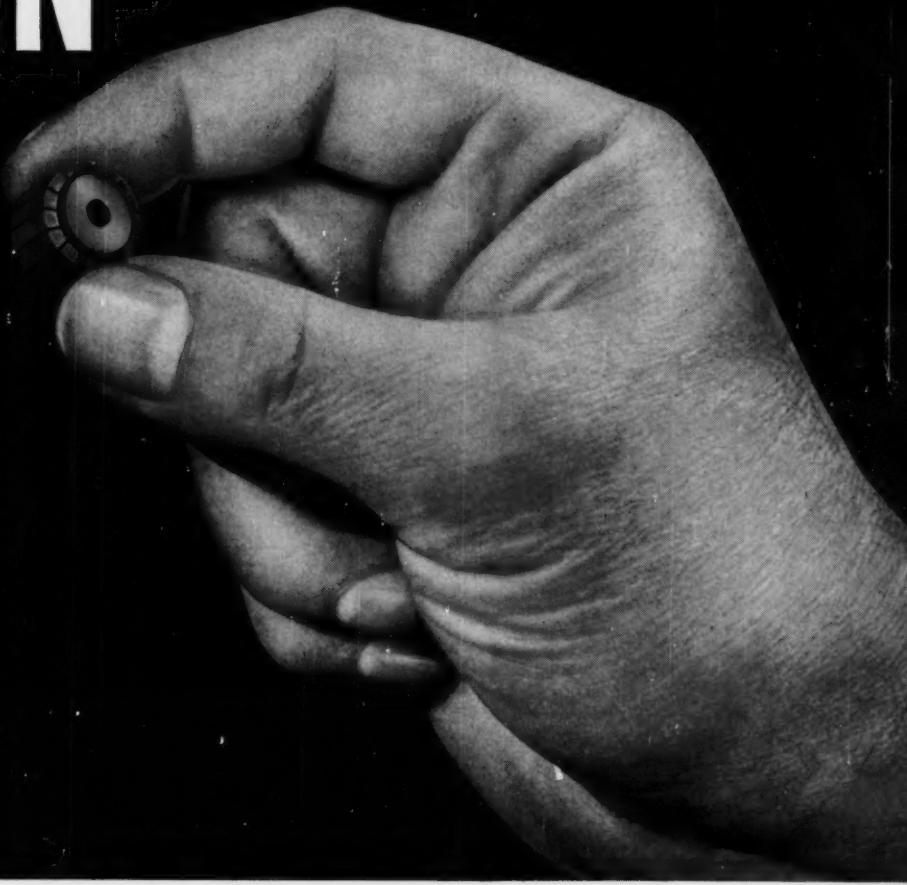
March 28-29—

Symposium on Nucleonics in Flight to be held at the Statler-Hilton Hotel, Dallas, Texas. Symposium will consider nuclear aspects of atmospheric and space systems for manned and/or unmanned space travel. Further information is available from Eldred L. Burkhardt, Chairman, North Texas Section, American Nuclear Society, Convair Div., Fort Worth, Texas.

April 17-19—

Seventh National Symposium on Instrumental Methods of Analysis, to be held at the Shamrock-Hilton Hotel, Houston. Sponsor is the Instrument Society of America; additional information is available from Meetings Services Dept., ISA, 313 Sixth Ave., Pittsburgh 22, Pa.

AGAIN-



Revere helps "fit the metal to the job"

**AND A COMMUTATOR MANUFACTURER SAVES ON BOTH MATERIAL COSTS
AND OVERALL COSTS WHILE PRODUCING A SUPERIOR PRODUCT**

The hub of the small commutator you see above originally was made of a ferrous metal. Certain problems cropped up due to the fact that the rod from which the hubs were fabricated, not only had to be drilled, but it also had to be able to withstand a flanging operation. The engineering department of Dayton Precision Manufacturing Company called in one of Revere's Technical Advisors for consultation.

After a thorough study of the problem Revere Brass Rod of a certain alloy was recommended and samples were furnished. The machinability of the rod was found to be outstanding, being readily and speedily drilled. Also it withstood the flanging operation . . . a set of manufacturing conditions where only brass, the right kind of brass, outshines all other metals and alloys.

Final score: The low first cost of the brass rod, plus its

superior machinability, resulted in a more satisfactory product without the penalty of higher costs. A further advantage to the manufacturer was the added sales appeal of the brass hub.

And there you have another example of how Revere in collaboration with the manufacturer helped, "fit the metal to the job," which resulted in a better part at the least possible cost. Why don't you take advantage of this kind of service?

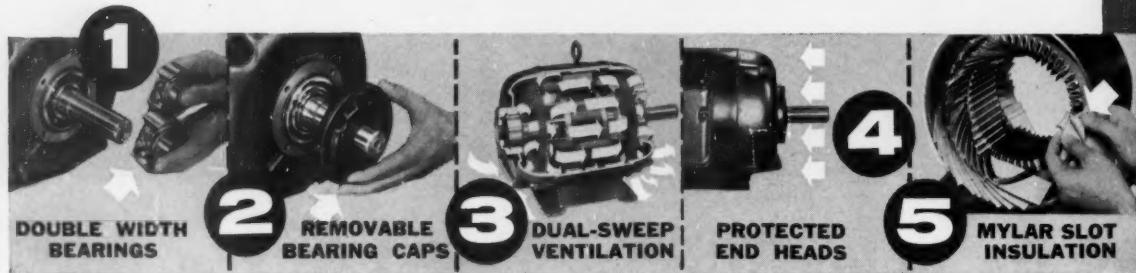


REVERE
COPPER AND BRASS INCORPORATED

Founded by Paul Revere in 1801
230 Park Ave., New York 17, N. Y.

Sales Offices in Principal Cities, Mills: Rome, N. Y.; Baltimore, Md.; Chicago and Clinton, Ill.; Detroit, Mich.; Los Angeles, Riverside and Santa Ana, Calif.; New Bedford and Plymouth, Mass.; Brooklyn, N.Y.; Newport, Ark.; Ft. Calhoun, Neb.
Distributors Everywhere.

WHICH R&M MOTOR FEATURE WILL ADD MORE TO YOUR PRODUCT'S COMPETITIVE ADVANTAGE?



All these outstanding features—*yours at no extra cost*—contribute to R&M's dependable performance, easy maintenance and long life. Fully sealed double-width bearings have extra-large reservoirs containing grease selected to resist dust, temperature, humidity and high speeds. Bearing inspection and relubrication are easy. Bearing cap on each end head comes off quickly when four bolts are removed. Bearing seal, held by removable snap rings, is also easily removed. "Dual-Sweep" ventilation greatly prolongs motor life with high-velocity cooling and cleaning. Tandem fans—one pushing, one pulling—create end-to-end ventilation that eliminates "dead" areas. Venturi baffles direct air over and around end coils. One-piece shrouded end heads give full-height protection against moisture and falling objects. Mylar* laminated to rag paper insures positive slot cell insulation because of its excellent dielectric qualities (8 times that of conventional insulation). Rag paper backing provides cushion against abrasion and puncture. Get complete information . . . write today for Bulletin 520-MD

*DuPont registered trademark

ROBBINS & MYERS, INC., Springfield, Ohio

Fractional and Integral HP Electric Motors • Electric Hoists and Overhead Traveling Cranes • Mayno_® Industrial Pumps

Propellair_® Industrial Fans • R & M-Hunter Fans and Electric Heat • Trade-Wind Range Hoods and Ventilators

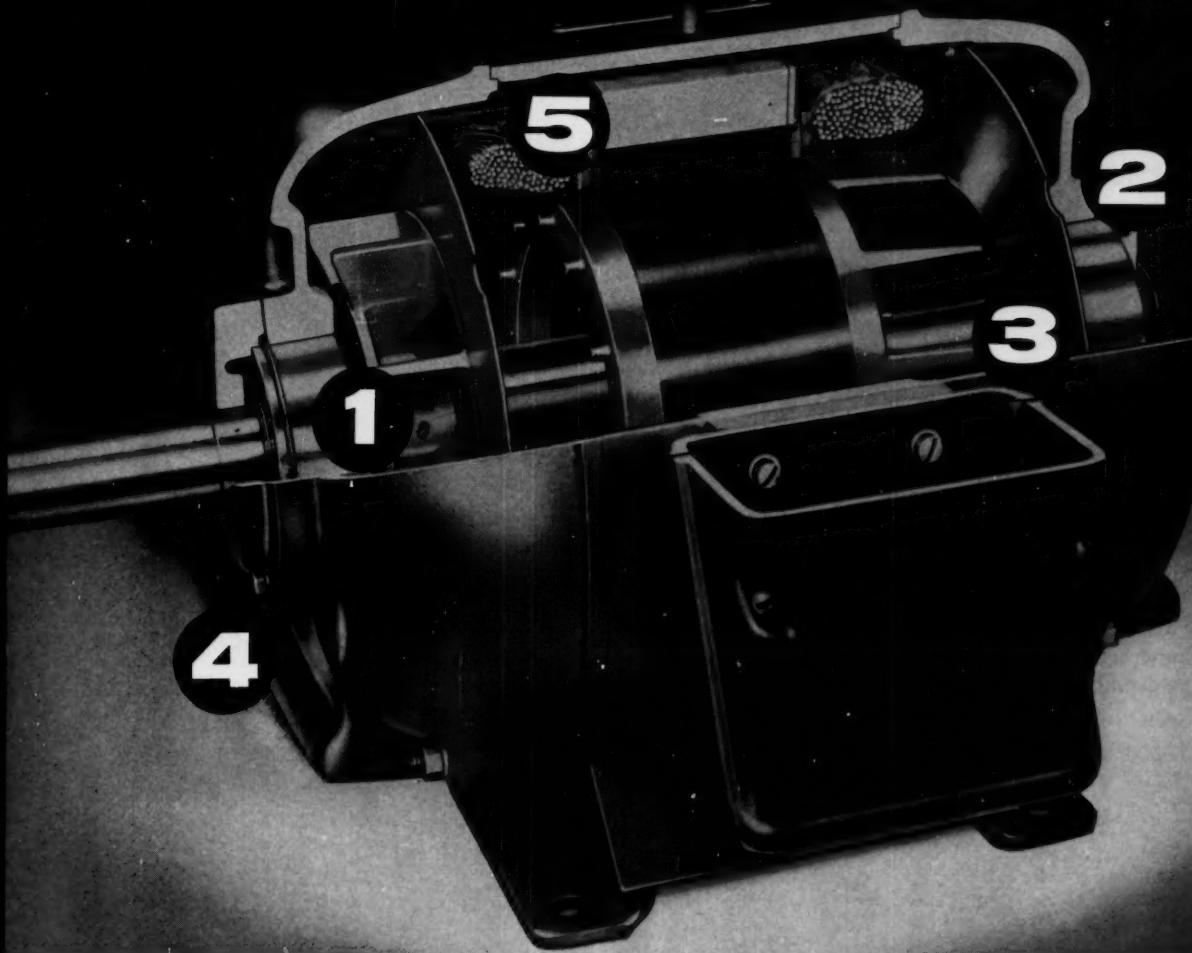
Subsidiary companies at: Memphis, Tenn., Pico Rivera, Calif., Brantford, Ontario.

Circle 424 on Page 19



MOTORS 1 thru 200 HP

(other ratings 1/200 to 1 horsepower)

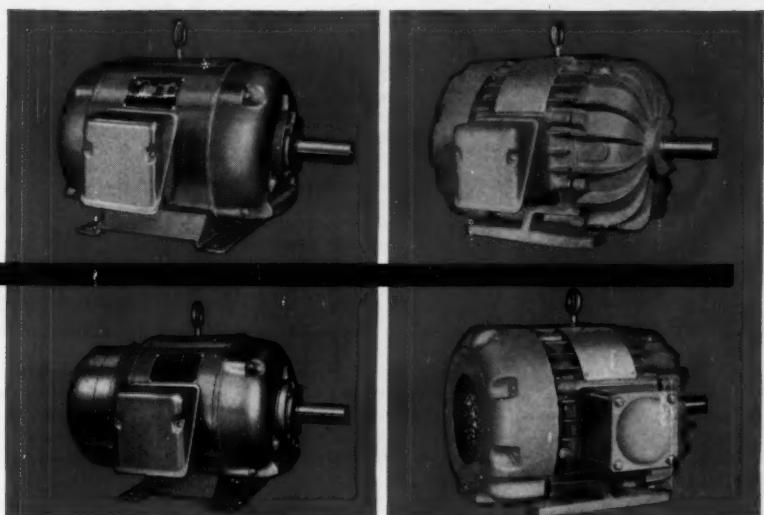


Open Protected Polyphase Motors (left), up to 200 HP, are suitable for many applications formerly requiring totally enclosed construction.

Totally Enclosed Motors (right), 1/2 to 200 HP, are fan-cooled . . . offer complete protection against all harmful atmospheres.

"PM" Single Phase Motors (left), ratings through 20 HP, eliminate maintenance because they are fully weatherized for severe duty.

Explosion-Proof Motors (right), ratings through 200 HP, are Underwriters' Approved for Class I, Group D, and Class II, Groups F & G.



How to design SALES

Here's why **GEORGE E. FAILING CO.**

ENGINEERING EXTRAS...

Diesel or carbureted interchangeability presents no problem for Failing engineers, and it gives them a plus feature they can pass along to the customer. There are other benefits, too. "The wide range of power sizes in the International line lets us use IH engines for many of our new models," says Research Engineer Herschel Bules shown here, at left, with Mr. Carley.

Failing has been building portable drilling equipment for thirty years and their experience has shown that International's many fine features go far beyond the drawing board. In addition to engineering advantages, rugged International engines provide the steady, dependable power needed on heavy-duty drilling rigs. Customer reports from all over the world prove the reliable performance of IH-powered Failing equipment.

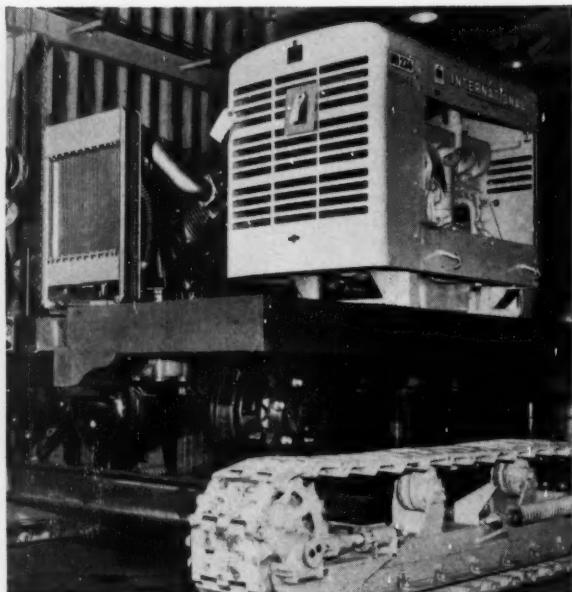


"The convertibility of either International gas or diesel power is a great asset. Similarity of mounting and accessories, and compact design further simplifies installation."

—EVERETT CARLEY, Chief Engineer,
GEORGE E. FAILING CO., Enid, Okla.



Here's an inspector on Failing's assembly line checking final installation of 75-hp carbureted engine. International carbureted engines are available in a variety of models, for gasoline, LP gas, natural gas or combinations. The UC-221 above, has the same rugged construction as its diesel twin shown at the right.



Interchangeable in size and power, the UD-236 is installed for customers who specify diesel operation. There are 35 engines in the International line—16.8 to 385 max. hp. Stripped engines or complete power units are available, and factory-made accessories and attachments further extend International flexibility.

POWER into Your Products

specifies INTERNATIONAL POWER...

SALES ADVANTAGES...

This prominent manufacturer gets three basic advantages by using International power. First, International's wide range of power sizes, with features for extreme adaptability in every size, presents a choice that will exactly match design specifications and power requirements. Second, International's world-wide network of parts and service facilities assures prompt attention to on-the-job problems—any time, any place. Third, Failing customers get long-lasting, low-cost power for heavy-duty drilling operations.

This three-way advantage provides desirable engineering extras, and creates a product preference that today's sales-conscious engineer demands. Find out today how you can build Sales Power into your products. Call or write to International Harvester Co., Engine Sales Dept., Melrose Park, Ill.



"Our company reputation and continued sales rely on customer satisfaction. International engines and the IH parts and service organization meet our high standards of equipment performance and service to the user."

—R. M. GREER, President,
GEORGE E. FAILING CO., Enid, Okla.

CUSTOMER PREFERENCE...

"We keep operation and maintenance costs in line by using 100% International power on shot hole and core drills."

—T. E. FAILING, President,
FAILING EXPLORATION & DRILLING CO.
Houston, Texas

In today's competitive market, designers are vitally interested in customer preference. That's why so many engineers insist on International. When you're ready to specify power, call International for complete product information and installation assistance. See how easy it is to design Sales Power into your equipment.

INTERNATIONAL[®]
IH. ENGINES

International Harvester Co.,
180 North Michigan Ave., Chicago 1, Ill.
A COMPLETE POWER PACKAGE
Circle 425 on Page 19



new-lube-free...



....Sterling's variable speed drive never requires lubrication

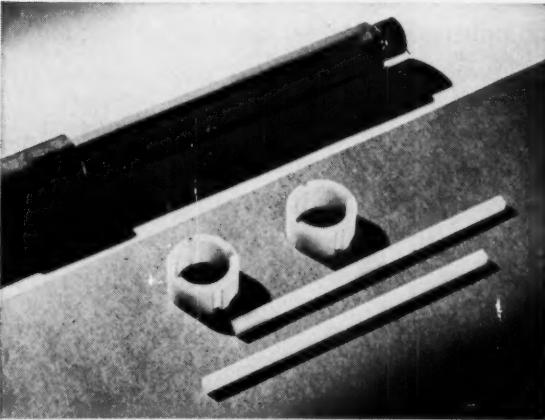
Costs Reduced—One of management's biggest headaches has been the development and maintenance of proper lubrication schedules. As a consequence, lubrication problems have long been the cause of variable speed drive failures, pulley wear, sticky pulleys, shortened belt life, excessive noise, and many other equally costly problems.

High labor costs, coupled with increased maintenance needs, are major management problems.

Lubrication Eliminated—Now, Sterling has eliminated all lubrication maintenance problems. No part of a Sterling variable speed drive needs to be lubricated.

All bearings, sealed and shielded, are factory-lubricated and therefore require no lubrication. Shaft surfaces are impregnated with a special exceptionally tough and wear-resistant material which eliminates need for lubrication. The non-metallic bushings are also fabricated from a special material that is equally wear-resistant.

Special Load-Bearing Surfaces—At no time do these surfaces require any attention. Even the keys are fabricated from a tough elastic material and will not wear out.



Shaft surfaces are extremely tough; material provides unusual chemical resistance and anti-frictional properties that make an excellent load-bearing material operating under extremely low or high temperatures. Keys and bushings are fabricated from a material proven to have outstanding abrasion resistance; holds up indefinitely under frictional conditions, thus eliminating need for lubrication.

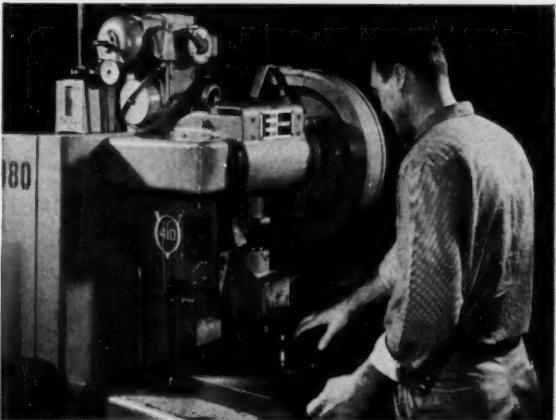
Fret corrosion, long a problem with metallic load-bearing surfaces, is completely eliminated since non-metallic surfaces now carry the load. Sticky pulleys, frequently the result of improper lubrication, are no longer a problem.

Sterling's new "Lube-Free" variable speed drive can be installed in any location, no matter how inaccessible, since lubrication maintenance is no longer needed.

Other Benefits—Costs are reduced, money saved, when lubrication maintenance is no longer necessary. Belt life is lengthened; pulley wear is eliminated. Bearing life may also be lengthened by the elimination of worn pulleys—often the cause of vibration and bearing wear.

All other Sterling variable speed advantages are present in this new "Lube-Free" drive: wide range of speeds, heavy-duty cast iron case, finger-tip speed control, etc.

Information Available—Complete application and product information is available by writing Dept. B-3, Sterling Electric Motors, Inc., 5401 Telegraph Road, Los Angeles 22, California—or by contacting the Sterling field engineer in your area.



This V & O Notching Press is powered by a new Sterling "Lube-Free" variable speed drive. It will never need lubrication. Similar units have been installed in the food processing industry. The elimination of lubrication is particularly important in the food processing industry where variable speed drives have such wide application, and where oil and grease create sanitation problems.



©1961 Sterling Electric Motors, Inc.

Sterling Electric Motors, Inc.

5401 TELEGRAPH ROAD, LOS ANGELES 22, CALIFORNIA,
A Subsidiary of HATHAWAY INSTRUMENTS, INC.

for long-life operation
despite extreme temperatures,
heavy shock, severe vibration

CLARE Type F

subminiature crystal can

RELAY

This hermetically sealed relay—no bigger than a postage stamp—is a precise component of unusual flexibility, capable of long-life operation under a wide variety of contact loads.

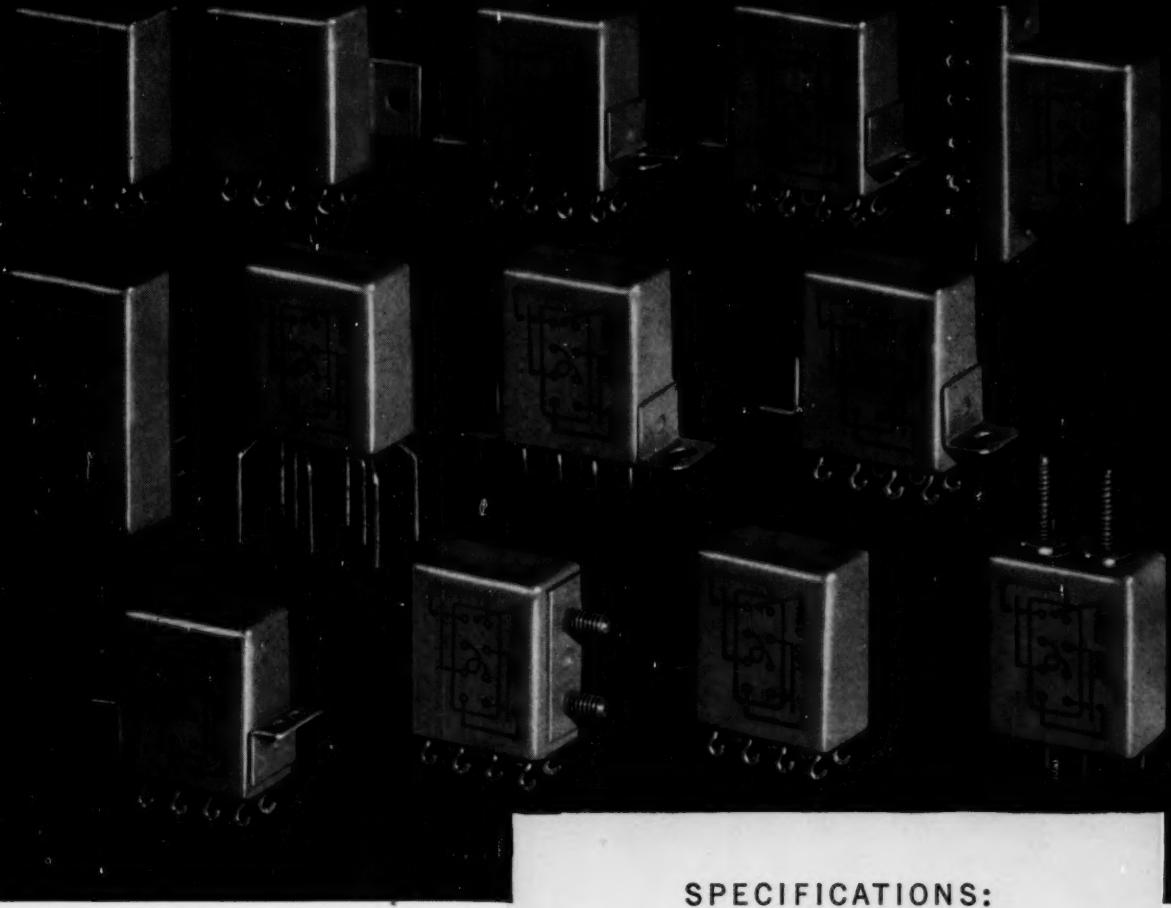
The Clare Type F is extremely fast and more than moderately sensitive. It is built to withstand temperature extremes, heavy shock and extreme vibration. It has proved its usefulness to advanced circuit designers. Contacts, rated at 3 amperes, are excellent for low-level circuit applications. Terminal arrangement is nicely suited to 2/10 inch grid spacing.

In a variety of terminal and mounting designs, the Clare Type F Relay is of real value for both commercial and military applications.

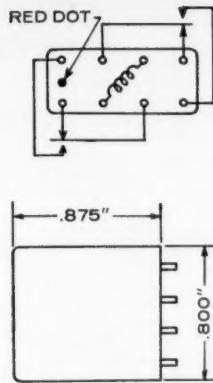
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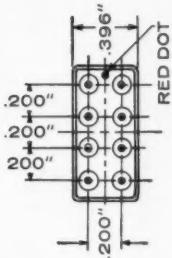
for complete data on construction, circuitry,
performance characteristics and mountings
... write for Catalog 203



SPECIFICATIONS:



wiring—
as viewed from
terminal end



For detailed information, ask your Clare Representative for Catalog 203... or address C. P. Clare & Co., 3101 Pratt Blvd., Chicago 45, Illinois. In Canada: C. P. Clare Canada Ltd., 840 Caledonia Road, Toronto 19, Ont. Cable address: CLARELAY.

Ambient Temperature.....	-65° C to +125° C.
Shock.....	65 G's, 11 millisecond duration.
Vibration.....	5-75 cps at total excursion of $\frac{1}{8}$ -inch, 75-2000 cps at 20 G's acceleration.
Dielectric Strength.....	Sea level—1000 volts rms between terminals and frame, and between adjacent circuits; 600 volts rms between contacts of a set. At 80,000 ft., 350 volts rms.
Insulation Resistance.....	1000 megohms minimum at 125° C.
Coils.....	Coils from 35 ohms to 10,000 ohms available for a wide range of voltages or currents.
Nominal Operating Power	.250 milliwatts.
Total Pickup Time.....	5.0 milliseconds.
Total Dropout Time.....	5.0 milliseconds.
Contact Arrangement.....	2 pdt (2 form C).
Contact Rating.....	3 amps resistive at 28 vdc or 1 amp resistive at 115 vac; also for low-level applications.
Contact Resistance.....	0.050 ohm maximum.
Contact Life.....	250,000 operations minimum at 2 amps; 100,000 operations minimum at 3 amps.
Enclosure.....	Hermetically sealed, filled with dry nitrogen at 1 atmosphere pressure.
Mounting.....	All popular mounting arrangements available.
Terminals.....	Printed circuit; solder; plug-in (matching socket available). Variations of printed-circuit terminal length on 2/10 inch grid spacing available.
Weight.....	17 grams.
Military Specifications.....	MIL-R-5757D.



C. P. CLARE & CO. Relays and Related Control Components

\$1500 IN PRIZES FINDING NEW USES FOR AVDEL'S CHOBERT BLIND RIVET SYSTEM

THE WORLD'S

F A S T E S T .
·
S E T S

2000 RIVETS PER HOUR



If you can use this speed or if you know of an application, enter Avdel's Chobert "2000 Per Hour Contest."

\$1,000.00 GRAND PRIZE

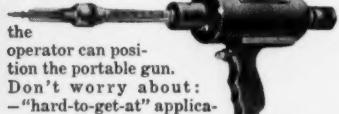
\$200.00 2ND PRIZE

\$50.00 3RD PRIZE

10 special awards of \$25.00 each

This is sort of a sneaky way to get you to think of applications for Avdel's Chobert Blind Rivet System. And why not? If you can tool up to set 2000 blind rivets per hour — think of the increased production and higher profits — so — you can be a hero and also win a prize.

The Automatic High Speed Riveting Gun holds a mandrel of up to 65 rivets, each automatically held ready for installation as fast as



the operator can position the portable gun.

Don't worry about:

— "hard-to-get-at" applications — special conformations — rivet alloy — Avdel's Chobert System can whip them all and still set 2000 blind hollow rivets per hour. Think of — metal to wood — cloth to metal — as well as metal to metal fastening applications. It's easy... wherever SPEED is an ESSENTIAL condition of a rivet-fastening application... Avdel's Chobert System shines.

RULES FOR AVDEL CONTEST

1. Submit as many entries as you wish.
2. Submit your entries on your company letterhead, if available to you; otherwise on 8 1/2 x 11 white paper.
3. Each entry shall include *all* the following information:

a. What applications your company now has for rivets of any kind. **b.** What your idea is for a prize-winning application using Avdel's 2000-per-hour Rivet System. Simply and clearly describe this application, the materials to be fastened, and the industry or industries in which the application can be used. **c.** State your name, address, occupation, and your title or job description in your company. **d.** Your entry need not necessarily be an application usable only in your own company. If you *know* of an application in another company which can use Avdel's 2000-per-hour speed to advantage, describe this application, and submit the name, title, company and address of the individual and company who should be interested. **e.** The more uses to which your idea may be put, and/or the newer the use, the more your chances increase to win important prizes.

4. All entries become the sole property of Avdel, Inc., to be used by them in any manner they see fit, including the use of your name, picture, and application idea in future advertisements.
5. The decision of the judges is final; and no employees or relations of Avdel, Inc., or its advertising agency, are eligible.
6. All entries must be postmarked not later than April 15th, 1961.
7. Send all entries to AVDEL®, Inc., 210 So. Victory, Burbank, California.

working with

Du Pont **Delrin**[®]

one of Du Pont's versatile
engineering materials



**New
instrument
housing of
DELRIN[®]**

cuts weight 80%...simplifies assembly

In designing a compact automobile, weight reduction stands out among the objectives—less weight means improved fuel economy and easier handling. That's one of the reasons why Chrysler Corporation's 1961 Valiant has a one-piece instrument housing molded of Du Pont DELRIN acetal resin. At no sacrifice in performance, the use of DELRIN cuts the weight of the instrument housing by approximately 80%—from nine pounds in die-cast zinc to two pounds in DELRIN. This reduction not only pays off in lower over-all weight, but also eases handling on the assembly line.

The attractively styled housings of DELRIN have proved their durability through extensive road and laboratory tests. DELRIN offers strength in thin sections, even at elevated temperatures . . . remains dimensionally stable under varying conditions of humidity. Mounting of the housing is simplified because molded-in bosses accept self-tapping studs.

On the following page you will find more examples of the product improvements and savings in manufacturing and assembly costs made possible by DELRIN acetal resins in a variety of diverse fields.



REG. U. S. PAT. OFF.
BETTER THINGS FOR BETTER LIVING
THROUGH CHEMISTRY

Working with
Du Pont Delrin

one of Du Pont's versatile
engineering materials



The manufacturer of these valve components for check valves in water or gasoline pumping systems reports: "Severe testing proves that the disc retainer guide made of DELRIN is practically indestructible." Use of DELRIN instead of brass also prevents mineral build-up . . . eliminates the cause of valve sticking and faulty seating. (Molded by Holman Mfg. Co., for a division of Flomatic Corp., both of Hoosick Falls, N. Y.)



Shock absorber designed to eliminate water-hammer noises in residences has outer shell molded of tough Du Pont DELRIN. Reason for this choice: the shell of DELRIN is highly resistant to damage from residential shock pressures, exterior corrosion from most chemicals and water at 180°F. ("Genie" is molded for Josam Mfg. Company, Michigan, Indiana, by Stelrema Corp. of Gary, Indiana.)



A complete line of miniature oil-tight push buttons (colored buttons, rings and knobs) molded of Du Pont DELRIN to help provide easy identification. Designed for the toughest applications, these push buttons rely on the toughness, color variety, durability and wear resistance of Du Pont DELRIN acetal resin. (Manufactured by General Purpose Control Department of General Electric Co., Bloomington, Illinois.)

Parts of DELRIN® offer rugged, dependable performance under tough conditions

The strength, durability and dimensional stability of DELRIN acetal resin are particularly important when the part in question is subject to severe environmental conditions, such as high temperatures, moisture, solvent and many corrosive chemicals. In use after use, designers are continuing to find that DELRIN provides parts that will perform under these adverse conditions . . . plus substantial economies in manufacture and assembly. How about DELRIN for your product? Mail the coupon for further information.

POLYCHEMICALS
DEPARTMENT



BETTER THINGS FOR BETTER LIVING
... THROUGH CHEMISTRY

E. I. du Pont de Nemours & Co. (Inc.)
Department I, Room 2507-D
Nemours Building, Wilmington 98, Delaware

I am interested in evaluating DELRIN for the following use:

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Company _____ Position _____

Street _____

City _____ Zone _____ State _____

In Canada: Du Pont of Canada Limited, P. O. Box 660, Montreal, Quebec.

A
B

DELRIN® acetal resins

one of Du Pont's versatile engineering materials

Alathon® • Zytel® • Lucite®

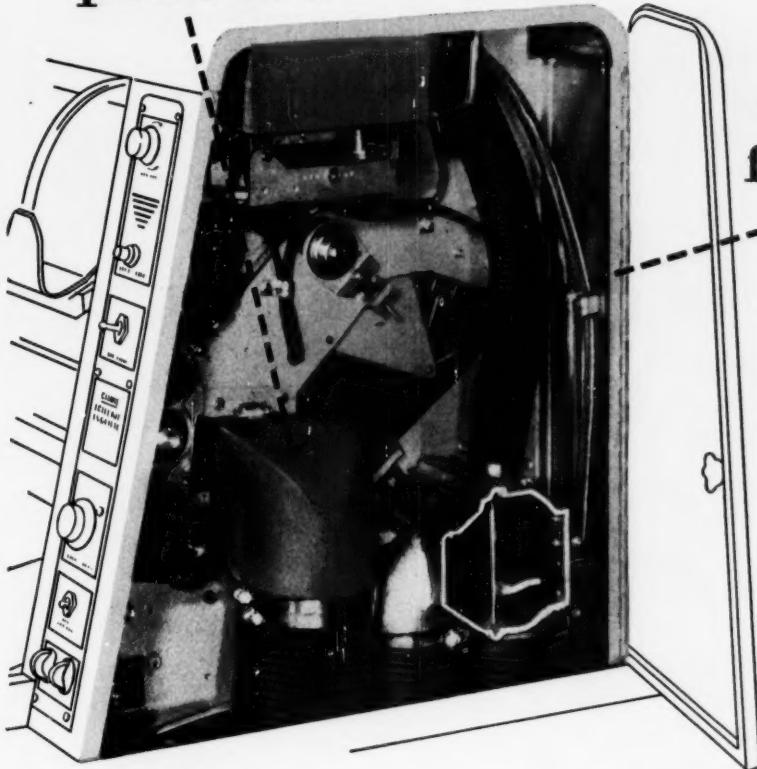
polyethylene resins

nylon resins

vinyl resins

In the Lancer Whiteprinter, Flexible Tubing

1...provides suction to
separate originals from
prints...



2...
conveys air
for cooling...

3...
exhausts
heat and
fumes

Proof that Flexible Tubing can solve a wide range of design problems

Copymation, Inc., designers of the LANCER Dry Process Whiteprinter, had to solve three tough air handling problems: how to provide suction... how to convey air for cooling... how to exhaust heat and fumes — all in a very limited space!

Solution to all three problems: a rugged nonmetallic duct with a wire helix — Flexible Tubing's "Flexflyte." Flexflyte is air tight and non-collapsing — provides strong, continuous suction for separating originals from prints. Flexflyte is lightweight and highly flexible — easily conveys air through cramped areas. Flexflyte is flameproof and corrosion-resistant — safely exhausts heat and fumes. Perfect example of the design problems solved with Flexible Tubing!

If you work on any kind of original equipment involving the handling of air, liquids or light solids, there's a Flexible Tubing product that can do the job! It's at work today in electronic computers, vacuum cleaners, farm combines and hundreds of other places. Consult your factory-trained Flexible Tubing regional sales engineer. He'll be glad to give you technical assistance.

FLEXIBLE TUBING CORPORATION 62 New Whitfield St., Guilford, Conn.

Gentlemen:
I'm designing a new product I'm redesigning an old one One of my problems is the handling of air liquids light solids Could be Flexible Tubing can help me solve them. I'll give you 10 minutes to show me, to prove it. Phone for appointment No problems right now. Send me literature for my files

NAME _____

COMPANY _____

ADDRESS _____

CITY _____ STATE _____



Flexible Tubing

CORPORATION

Anaheim (Los Angeles) • Guilford, Connecticut
Hillside (Chicago)

Here's 0.1° Sensitivity at a Competitive Price!

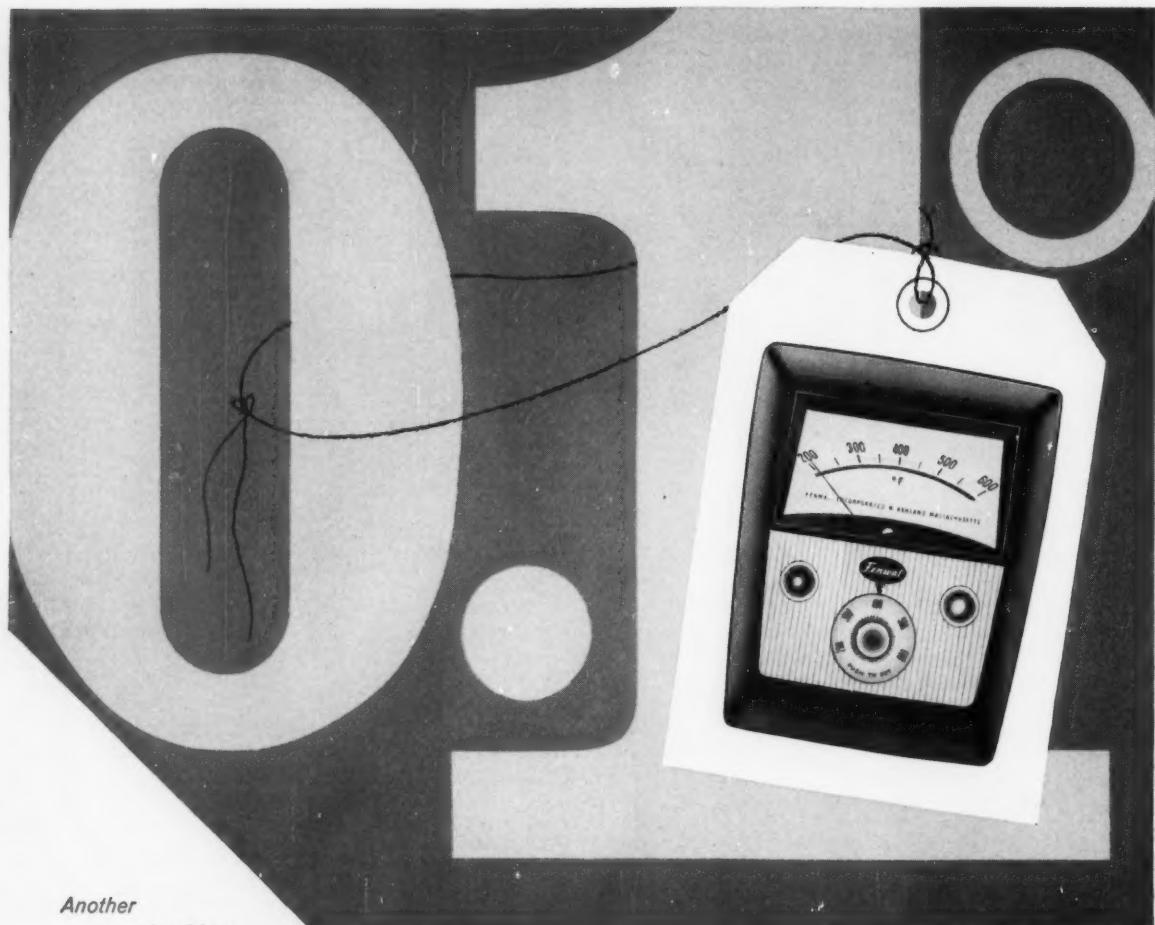
*... Fenwal's New "561"
Temperature Controller*

The new "561" indicating controller responds to temperature changes of 0.1° or less! And is yours at a competitive price! These two features alone make it an instrument you should investigate...but there's more!

You can choose from five standard temperature ranges . . . within the span of -50 to 600°F. Furthermore, scales start and end within *your* ranges, permitting larger graduations, better legibility, easier read-out. And control and indication are separate but simultaneous. *Should your indication fail the "561" will continue to control with complete accuracy.*

This precise instrument gives unvarying performance. Its indication and control will not vary with fluctuations of input voltage nor changes in ambient temperature. It offers the option of either ON-OFF or proportional control . . . has 10 AMP/120 VAC relay capacity. Smartly styled to complement modern industrial machines and interiors, the "561" offers you all these extras at a competitive price.

A Fenwal engineer will be glad to supply information on the "561", or any other temperature control in Fenwal's broad line. Write Fenwal Incorporated, 192 Pleasant Street, Ashland, Massachusetts.

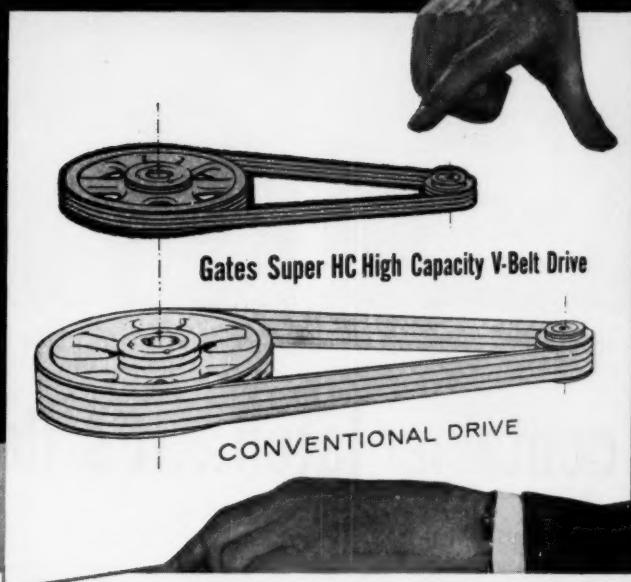


*Another
example of how*



CONTROLS TEMPERATURE . . . PRECISELY

*Need a better drive
for a machine?*



Ask your local Gates Engineer to show how Super HC Drives save space, weight, money

If you are designing a new machine or redesigning one for better performance, your local Gates Field Engineer will be glad to help you. He can show you how to take full advantage of the many opportunities offered by Gates Super HC High Capacity Drives.

Ask him to design a drive for your machine two ways: A conventional V-belt drive and a new Gates Super HC High Capacity V-Belt Drive. A quick comparison will show you many of the important savings provided by the new Gates drive.

Manufacturers everywhere have standardized upon the Gates Super HC V-Belt Drive—industry's first and most advanced high capacity drive. It is your best assurance that your power transmission unit will not soon become obsolete.

Your local Gates Field Engineer is an experienced, fully-qualified drive design expert. Contact him for drive design help.

The Gates Rubber Company, Denver, Colorado

Gates Super HC Drives give you these benefits:

Handles up to 3 times more hp than conventional V-belts in same space.

Saves up to 50% in drive space.

Reduces drive weight 20% and more.

Cuts drive costs as much as 20%.

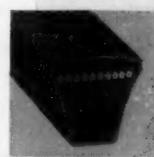
Reduces bearing load, increasing bearing life.

Guards can be smaller, lighter weight.

Belt speed up to 6000 ft/min possible without dynamic balancing.

Less costly, higher speed motors can often be used.

Exclusive design features include: precisely engineered arched top, concave sidewalls, Flex-Weave cover, super strength tensile construction.

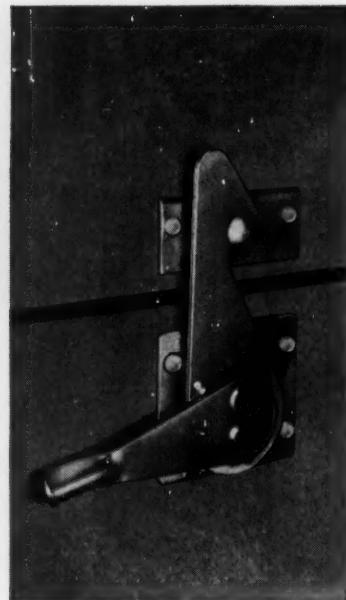


*Building the future on
50 years of progress*

Gates Super HC V-Belt Drives

WHAT HOOK-LOCK IS

HOOK-LOCK is a springless, positive-locking latching device which is ideally suited for use on rigidly specified military transit cases as well as less expensive commercial containers. It provides high closing pressure and tremendous load-carrying capacity...is impact and shock-proof. HOOK-LOCK is so designed that it lies flat against the mounting surface whether in open or closed position. Since operation is parallel to mounting surface, no space for operating clearance is required.

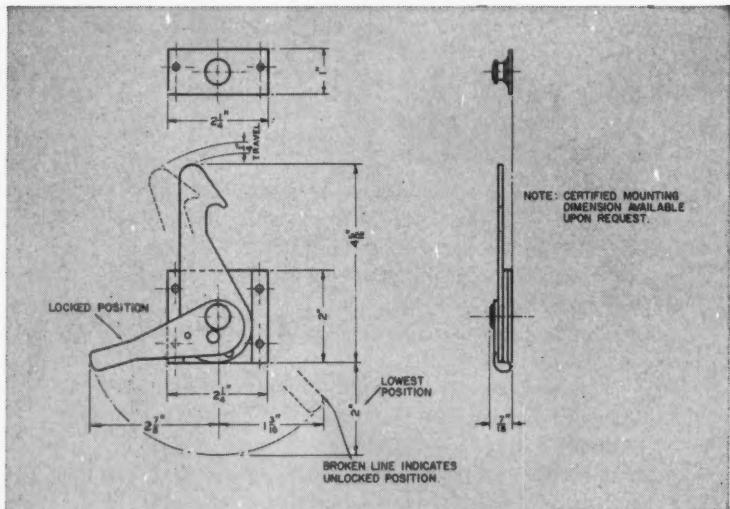


HOOK-LOCK lies flat against mounting surface, open or closed.

New—HOOK-LOCK container latch...It's flat!

FEATURES

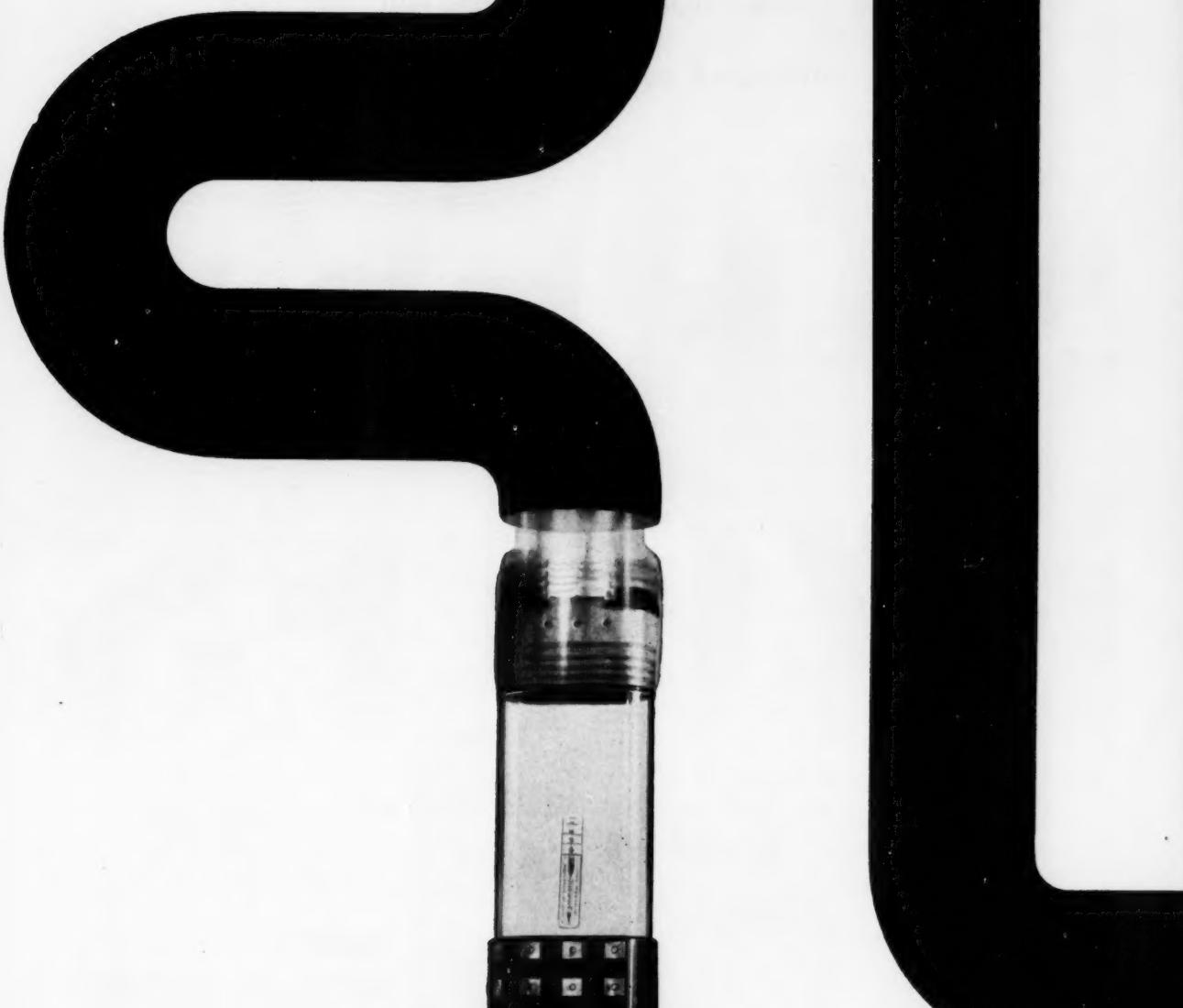
- Shock-proof—solid construction...withstands high impact blows directly on the fastener.
- Closing pressure of 200 lb. Where needed, pull-down pressure can be substantially increased by modification of operating lever.
- Tensile load capacity: 750 lb.
- Compact—lies flat open or closed. Extends just $7/16$ " from container surface at thickest point.
- Positive-locking and springless. Unaffected by arctic temperatures.
- No operating clearance required, because hook and lever move parallel to mounting surface.



IF YOU have questions regarding the possible application of HOOK-LOCK or other Simmons industrial fasteners to your particular needs, your inquiry will receive our immediate attention. Contact your nearest Simmons office or write direct.

SIMMONS **FASTENER CORPORATION**

1756 North Broadway, Albany 1, New York



IMPACT!

This is a "warhead". It's the front end of a carrier which darts through a pneumatic tube system at speeds up to 20 mph, and is subject to frequent shocks and impact. There's a story behind the choice of LEXAN® polycarbonate resin for this new design . . .

Formerly, destinations were set by contacts along the entire body of the carrier. Engineers of Airmatic Systems Corporation, Saddle Brook, New Jersey, reasoned that if all the control elements could be fitted into a small impact- and wear-resistant head, the rest of the carrier could be designed for easy maintenance and quick replacement. Many plastics had the required dielectric strength, but none

could measure up to LEXAN resin's combination of good electrical properties, excellent dimensional stability and extremely high impact strength. LEXAN resin actually withstands over 12 foot-pounds per inch of notch — an impact strength attained by no other plastic!

The new warhead is injection-molded of black LEXAN resin by Berkeley Engineering & Manufacturing Co., Berkeley Heights, N. J. Now when wear and tear take their toll, the transparent carrier body is easily replaced, since it has no control elements. Also, body length can be varied to suit customer needs, and carrier weight is reduced. Printed circuits and compactly arranged brushes and con-

trol plates are used. The new design is more attractive, more practical, less costly. And—LEXAN resin warheads have proved in field tests to last longer than the old control units.

G.E. LEXAN polycarbonate resin has raised the quality of many designs to new levels. It has been reduced in price approximately 40% over the past year! Can this tough, new thermoplastic help you? Send for design literature.

LEXAN®
Polycarbonate Resin

GENERAL ELECTRIC

Chemical Materials Dept., Section MD-21, Pittsfield, Mass.

Circle 435 on Page 19

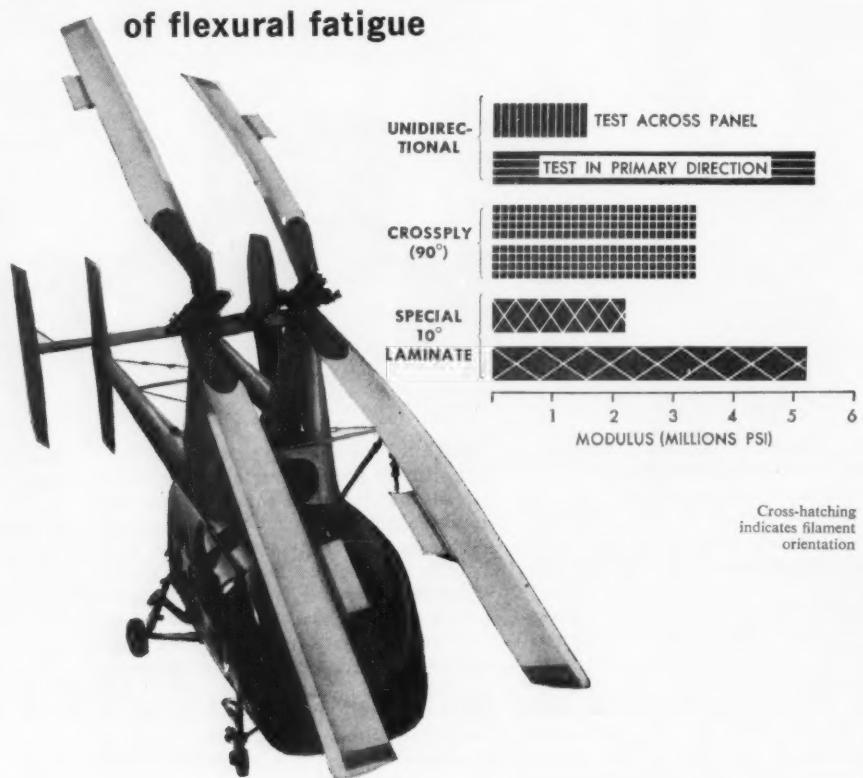
New structural material will
withstand over **2 BILLION**

STRESS CYCLES

at 25,000 psi with no evidence
of flexural fatigue

ROTATING STRESS LOADS are constantly changing on the modulus balancing cheek plate (indicated in blue) of this helicopter rotor by Kaman Aircraft. "SCOTCHPLY" is the only structural material tested that satisfied all requirements. Pliés are oriented to meet the tension, bending and torsion strains developed in the blades.

Modulus of elasticity taken in the lengthwise direction and crosswise direction for several laminate orientations are shown at right. Any intermediate ratios may be obtained as "SCOTCHPLY" can be tailored to meet specific stress requirements.



Now get maximum flexural-fatigue strength plus highest strength-to-weight ratios with "SCOTCHPLY" Reinforced Plastic. Tests show this amazing structural material will stand up under more than 2 billion flexes without fatigue failure.

The secret of the superior properties of "SCOTCHPLY" is that each ply consists of continuous straight filaments in parallel alignment, not crimped or woven. This continuous non-woven construction allows you to tailor individual plies to meet specific areas of high stress.

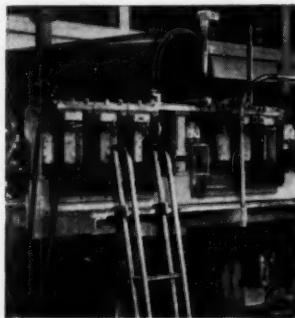
Weight and bulk is not wasted in directions or regions of low stress as with ordinary woven or short strand reinforced plastics. With "SCOTCHPLY" you customize the material to the job.

"SCOTCHPLY" Reinforced Plastic is available in epoxy, phenolic and other resin formulations with filaments of glass, nylon, asbestos or other materials. It is sold in uncured rolls or sheets containing a controlled ratio of filament to resin. Heat and low pressure in matched metal dies, or vacuum or pressure bag molding cure it into rigid form. It can then be sawed, machined, sanded, milled, turned, drilled, or tapped.

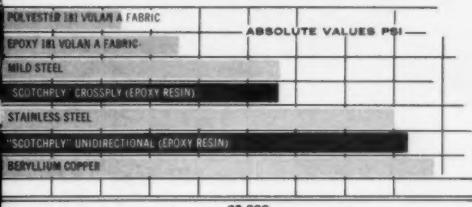
Discover how "SCOTCHPLY" can serve your needs. For complete information and technical service, write: Reinforced Plastics Division, 3M Co., 1210 University Ave., St. Paul 4, Minn., Dept. XAD-21.

FLEXURAL FATIGUE failure of metal Fourdrinier springs resulted in costly breakdowns on this paper machine manufactured by Rice Barton Corporation. Now Fourdrinier springs of "SCOTCHPLY"—tailored to the application—do the job.

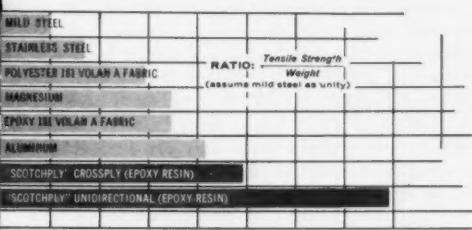
EXTREMELY HIGH TENSILE STRENGTH and light weight are essential in this battery case by Prewitt Aircraft for a classified missile. By proper orientation of reinforcing filaments, "SCOTCHPLY" provides maximum strength where strength is needed to withstand tremendous acceleration loads.



Flexural-fatigue strength @ 2×10^6 cycles



Tensile strength-weight ratios



"SCOTCHPLYL" IS A REGISTERED TRADEMARK OF THE 3M CO., ST. PAUL 6, MINN.
EXPORT: 99 PARK AVE., NEW YORK 16, NEW YORK. CANADA: LONDON, ONTARIO

SCOTCHPLY®

BRAND REINFORCED PLASTIC

The logo for the Minnesota Mining and Manufacturing Company. It features the company name in a bold, serif font, with 'MINNESOTA' on the top line, 'MINING AND' on the middle line, and 'MANUFACTURING COMPANY' on the bottom line. To the right of the text is a circular emblem containing the '3M' logo, which consists of the number '3' and the letter 'M' intertwined, with the word 'COMPANY' written below it. The entire logo is set against a dark background.

... WHERE RESEARCH IS THE KEY TO TOMORROW

NEW Allen-Bradley Relay with EXCLUSIVE Permanent Magnet Latching



Saves Panel Space

**Gives Millions
of Trouble Free
Operations**

**Holds Closed Without
Coil Current**

Two to Six Poles

Bulletin
700

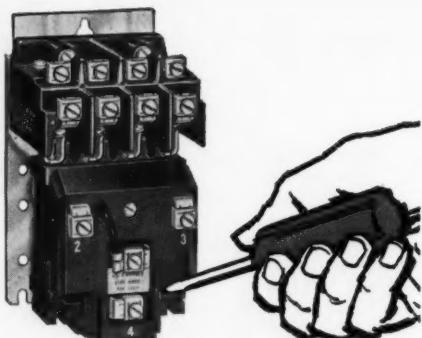
**TYPE
BRM**

Here's a completely new "latching" relay—which does not use a mechanical latch! It is the Bulletin 700 Type BRM—built to provide the same millions of dependable operations you get from all Allen-Bradley's industrial relays. A "built-in" permanent magnet eliminates the mechanical latch and the usual troubles caused by mechanical linkages.

When the coil of the new Bulletin 700 Type BRM relay is energized, the relay closes and is held closed after the coil circuit is opened—by a permanent magnet. Energizing the coil in opposition to the permanent magnet field opens the relay. The correct polarity for operation of the relay is obtained from silicon diodes held within the molded coil cover. With no "piggy-back" additions out in front, and no "extra" solenoids below, the Type BRM relay saves valuable panel space.

These A-B Type BRM relays also feature a continuous duty coil that permits the current to be left on, if desired. As with all Allen-Bradley relays, the double break, silver contacts never need attention. And the contacts of these new magnetically latched relays afford the same 60-second convertibility of the popular Bulletin 700 Type BR relay.

For latching relay service, it will pay you to investigate this new and completely different relay. It provides the usual Allen-Bradley quality!



Can be latched
or unlatched by hand

ALLEN-BRADLEY

Member of NEMA

Allen-Bradley Co., 1333 S. First St., Milwaukee 4, Wis. • In Canada: Allen-Bradley Canada Ltd., Galt, Ontario

**QUALITY
MOTOR
CONTROL**



These chips cost money. They represent dollars in wasted materials together with the time and labor cost of extensive and unnecessary machining. You can eliminate all of this through the use of Investment Castings.

There are many advantages gained when you use Investment Castings. Parts now made by other means or those now on your drawing board for your designs large or small, simple or complex, can be economically reproduced — in tens or thousands — in most castable alloys and to

meet your specifications and design requirements.

Investment Castings will reduce tooling cost, machining time and provide the latitude for designs otherwise impossible.

Send for our Investment Casting Catalogue now. We have representatives in most industrial areas and they'll be happy to discuss your problems with you.

Let the chips fall where they may. We know we can save you money and time using Investment Castings.

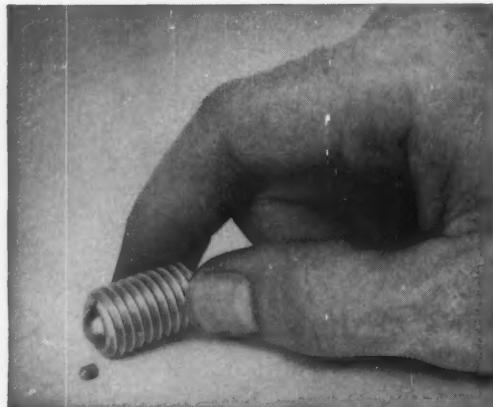


INVESTMENT CASTING COMPANY

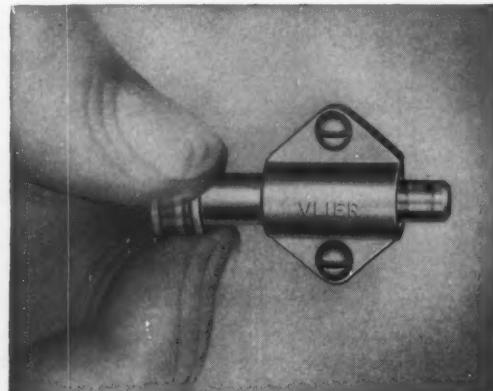
60A Brown Avenue • Springfield, New Jersey

Practical Design Tips

No. 4 of a series

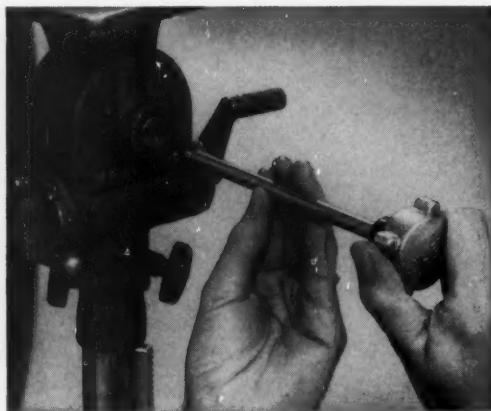


BALL PLUNGERS WORK BETTER than spring plungers when side loads are involved. Balls won't bind from side thrusts, retract easily. Available in 10 standard sizes from 4-48x3/16" to 5/8-11x1". Various end pressures. Special sizes and end pressures made to quantity orders.



NEED A SMALL, LIGHTWEIGHT, SPRING-LOADED LATCH? One enterprising designer modified a standard Vlier S-88 Spring Stop that did the job perfectly. Entire latch weighs less than 1/3 oz. Body is die-cast aluminum; plunger is heat-treated alloy steel. Various plunger pressures. Available on quantity orders only.

Hundreds of companies are now saving by using off-the-shelf Vlier products like the ones shown below. These simple, low cost, precision parts save designers time and, in many cases, simplify product design and manufacture. Why not investigate their possibilities today.



TORQUE-LIMITING WRENCH for assembling small parts, adjusting set screws, etc., is easily made from a Vlier Torque Handle and a length of hexagon stock. Prevents over-tightening, and subsequent damage to parts. End pressure is adjustable from 15 to 200 lbs.



FREE IDEA BOOKLET. Illustrations in this 16-page booklet show how others have profited from the use of Vlier products. Illustrates both the usual and unusual applications. May suggest ways *you* can save. Write for your copy today.

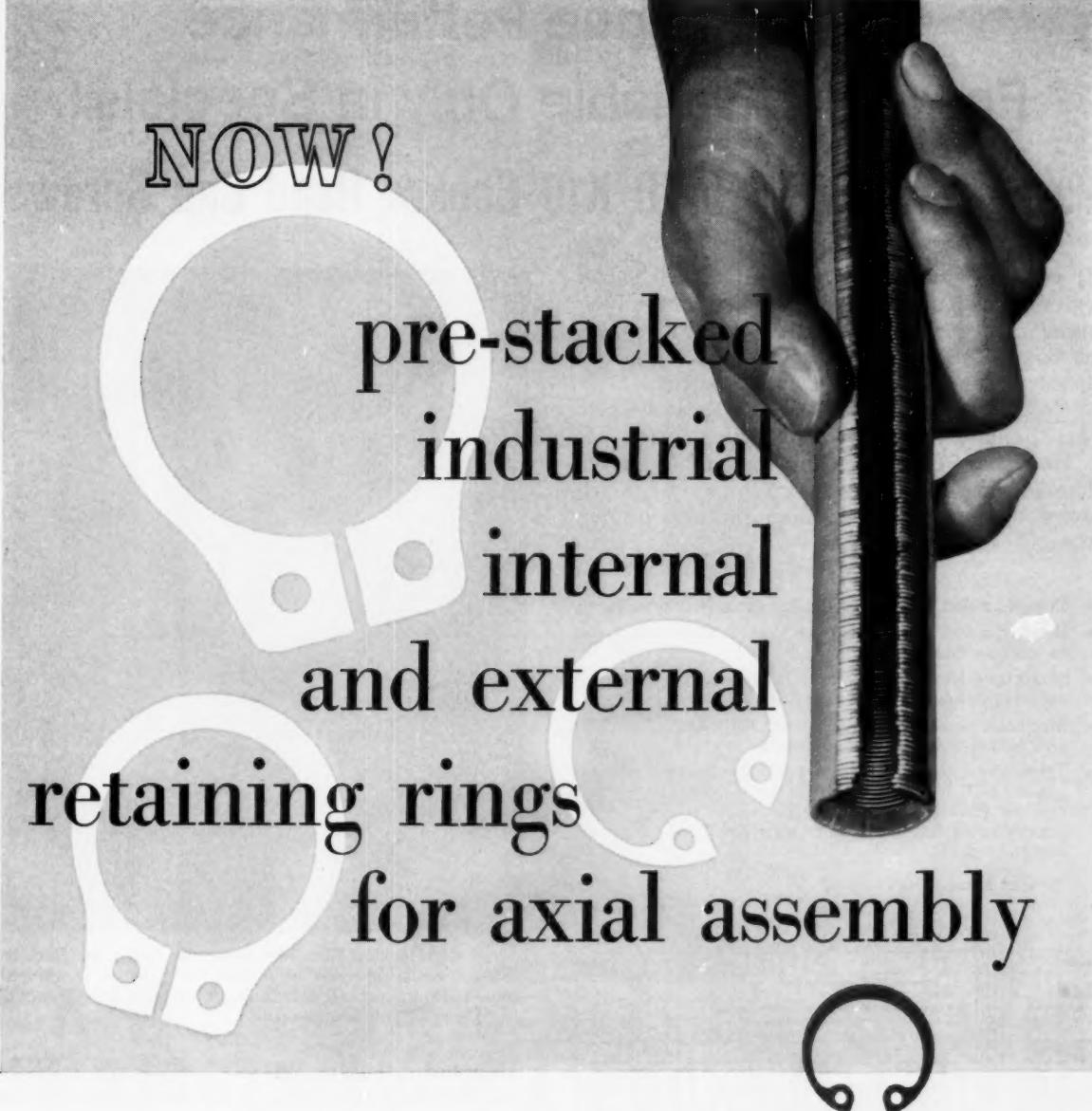
VLIER

Engineering Corporation

A subsidiary of Barry-Wright Corporation

8900 Santa Monica Blvd. • Los Angeles 46, California





NOW!

pre-stacked
industrial
internal
and external
retaining rings
for axial assembly

You can now get Industrial Series 3000 and Series 3100 Retaining Rings, PRE-STACKED—in the most popular sizes—from .250" to 1.375". You can get them immediately and for no more than you have been paying for bulk rings.

These Industrial Retaining Rings—both INTERNAL and EXTERNAL—come pre-stacked, with lugs aligned, in stacks of 250 . . . ready for automatic or semi-automatic dispensing.

You need waste no time untangling snarled rings—you don't have to guess at inventories on hand. And, you don't have to pay any premium for these money saving conveniences.

Your IRR Distributor carries Industrial Pre-Stacked Retaining Rings . . . or, write us for complete information.

Send for Catalogs No. 30M and 31M.

IRR *Originators of modern retaining ring dispensing*
INDUSTRIAL RETAINING RING COMPANY
57 Cordier Street, Irvington 11, New Jersey

Now—Fatigue Performance Formerly Available Only in Specials! ...with New UNBRAKO K16 Socket Head Cap Screws

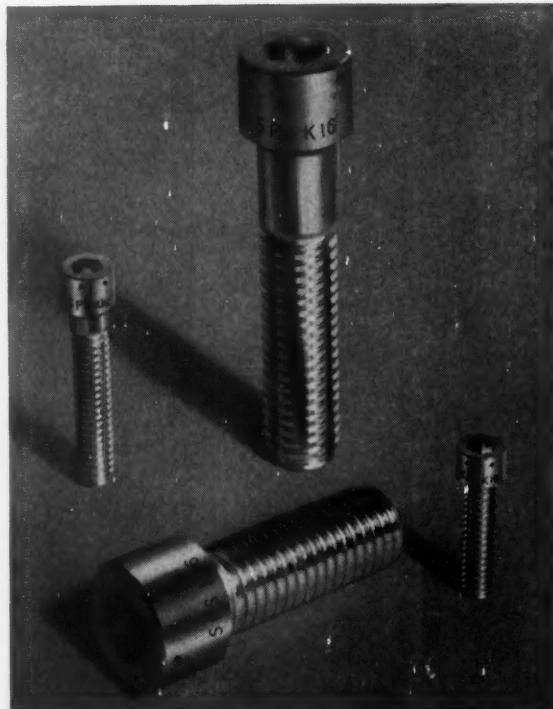
If you have socket-head applications demanding extra-normal fatigue capacity . . . if you have been using costly specials to get fatigue strength . . . here at last is a standard fastener designed specifically to solve your problem.

New UNBRAKO K16 socket head cap screws give you *a bonus of 300% more fatigue life*.

How does SPS achieve this special fatigue performance in a standard fastener? Primarily through extra operations during manufacture. Among them—

- Threads rolled *after* heat treat for extra fatigue strength
- Head-to-shank fillet area cold worked after heat treat to increase fatigue resistance
- Shank precision ground after heat treat to insure no decarburization and for closer body tolerances
- Magnetic particle inspection per SPS Specifications and MIL-I-6868 to insure a reliable product
- These features are in addition to the proven UNBRAKO pHd* head, which delivers far greater holding power, and the SPS Hi-Life thread root form, which reduces stress concentrations . . . both standard on all UNBRAKO socket head cap screws.

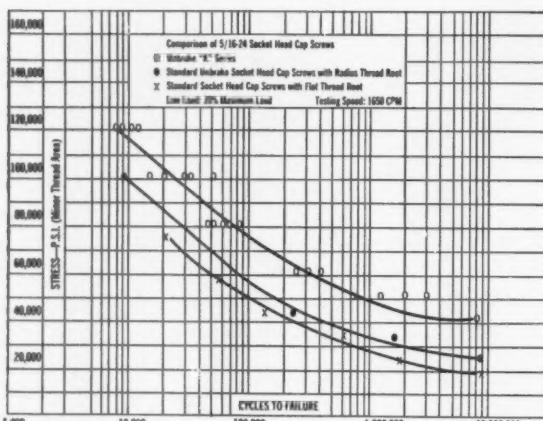
*proper Head design



New K16 tension fasteners were developed by SPS to replace costly specials in a growing number of critical industrial applications demanding extra-high fatigue capacity. Cross drilling is standard.

Case histories show that 90% of today's fastener failures are due to fatigue—a direct result of the trend toward more and more compact designs, with higher performance demanded of fewer or smaller components. New UNBRAKO K16 socket heads help you meet this design challenge . . . without paying for specials.

UNBRAKO K Series fasteners are available currently as socket head cap screws in standard sizes #8 through $1\frac{1}{2}$ in. diameter in 8740 A.Q. steel. Other configurations and series to come. See your authorized industrial distributor or write Standard Pressed Steel Co. for new Bulletin 2707. INDUSTRIAL FASTENER Division, SPS, JENKINTOWN 18, PENNA.

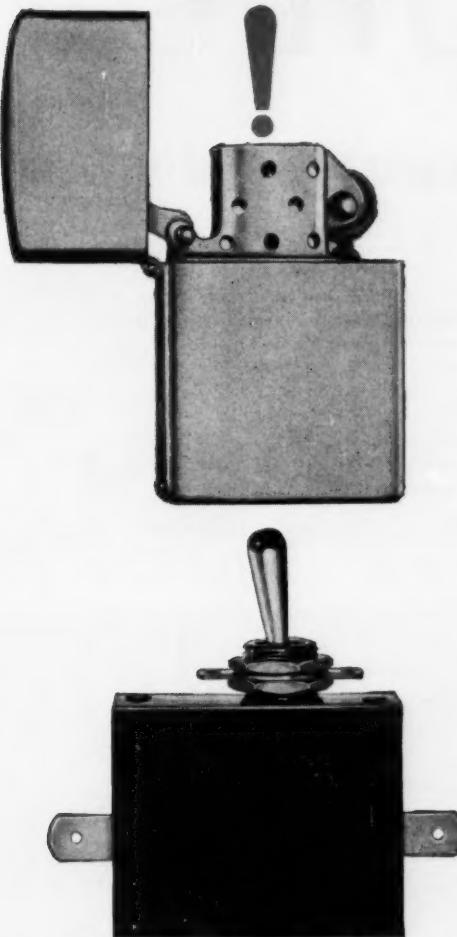


Tension-tension fatigue tests by SPS Laboratories show new UNBRAKO K16 socket head cap screw offers *twice the fatigue life of regular UNBRAKOS*.

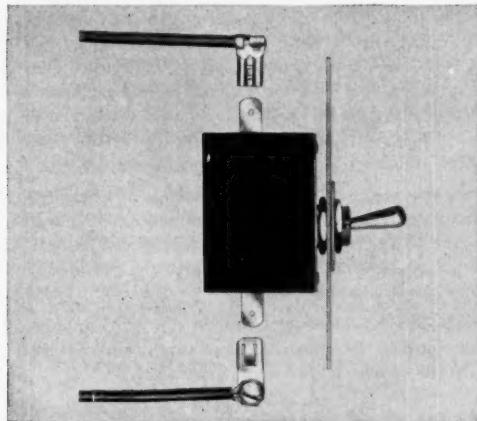
SPS

where reliability replaces probability

LOOK



A NEW HYDRAULIC-MAGNETIC BREAKER NO BIGGER THAN A POCKET LIGHTER



Light . . . small . . . a snap to install! This 1½-ounce circuit breaker can help you out of a tight spot, if you're cramped for component space. Only 2½" x 5/8" x 2¼" overall, it can take the place of both a fuse and a switch—and save you installation time and trouble, in the bargain. A single half-inch hole is all you need for mounting, and there are only two connections to make, instead of four or more. (The breaker's "universal" terminals let you use the kind of connection best suited to the job, too—soldered, solderless, or screwed.) You can have this breaker in any integral or fractional current rating from 0.050 to 15 amps, at 110V, 60 or 400 cycles AC, or 50V DC. Whatever rating you spec will be decimal-point precise—and permanent (you don't have to de-rate the hydraulic-magnetic breaker for high ambient temperatures). Bulletin VP will give you more information. A word from you will put a copy in the mail.

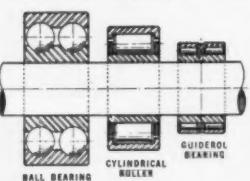
HEINEMANN ELECTRIC COMPANY ◇ 172 BRUNSWICK PIKE, TRENTON 2, N.J.

SA 2326

McGILL®

GUIDEROL® bearings offer higher load

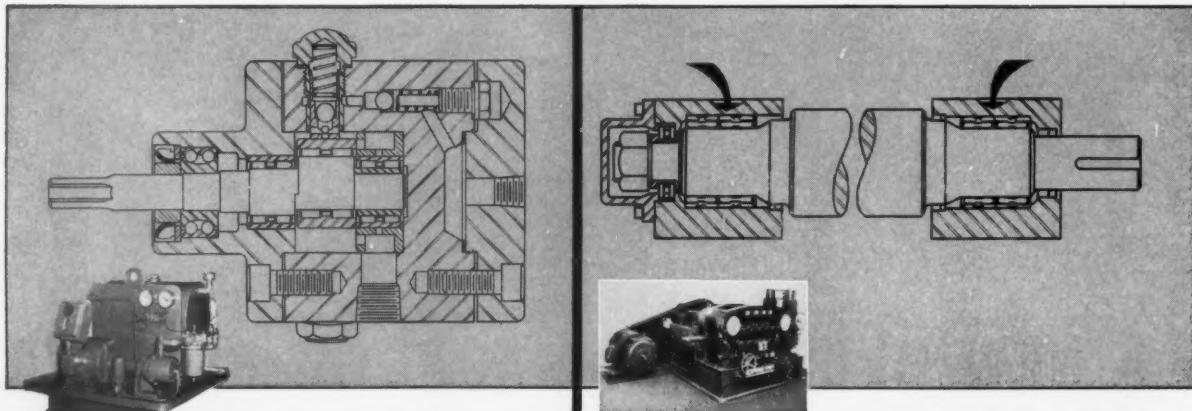
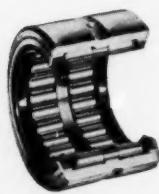
GUIDEROL bearings pack more high capacity performance into smaller radial space. Their construction features the extra capacity of a full complement needle bearing and effective roller control. Center guided rollers limit skewing and prevent binding under adverse conditions in either horizontal or vertical mountings. For a common 1" shaft, the GUIDEROL bearing has an O.D. of only 1½" with a capacity of 6310 lbs. Compared to a cylindrical type roller bearing, the GUIDEROL bearing requires $\frac{3}{8}$ " less housing space and offers 23% more capacity. A ball bearing for the same shaft uses almost an inch larger O.D. to carry 1500 lbs. less radial load. Space-saving GUIDEROL bearings simplify design and cut housing space requirements. Available with or without inner rings in shaft sizes from $\frac{1}{2}$ " to $9\frac{1}{4}$ " with capacities ranging from 2880 lbs. to 128,670 lbs. (at 100 RPM).



Sealed Guiderol Bearings Protect Performance Life and Cut Maintenance

Pre-lubricated and sealed GUIDEROL bearings lock lubrication in and seal contamination out.

Interchangeable dimensionally with GUIDEROL GR Series bearings, they cut maintenance in two ways. Bearings last longer and frequent re-lubrication is not required. 5 different seal combinations are available to fit specific mounting requirements.



SIMPLEX ENGINEERING USES GUIDEROL BEARINGS IN HIGH PRESSURE HYDRAULIC PUMPS

The SECO "LA" Series pumps, shown in cross section above, are fixed displacement seven piston radial pumps, utilizing unique patented principles which enable them to generate pressures as high as 10,000 PSI without loss of mechanical efficiency. SECO pumps are manufactured by the SIMPLEX ENGINEERING COMPANY, a subsidiary of RACINE HYDRAULICS & MACHINERY, INC.

MCGILL GUIDEROL MT Series bearings are used as shaft support bearings, and center eccentric floating bearings in these and other series Simplex pumps.

SIMPLEX reports unusual success with heavier loads and most satisfactory bearing life through ten years of use of MCGILL bearings. They have helped to produce the strikingly long life for which these pumps have become famous.

KANE AND ROACH LEVELER SHAFTS ROLL ON GUIDEROL BEARINGS

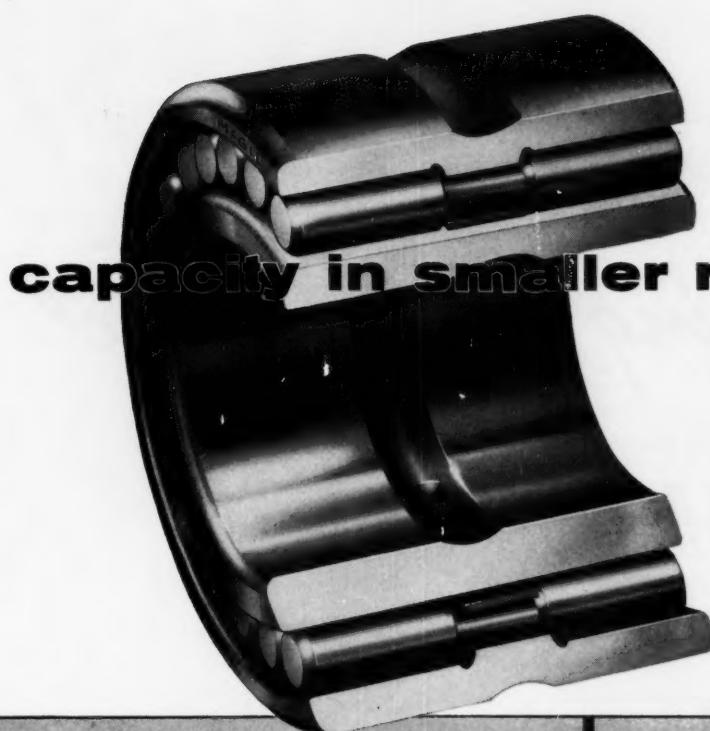
Kane and Roach depends on 26 matched pairs of GUIDEROL bearings to carry the leveling and flat straightening loads resulting from rolling alloy steels of 80,000 PSI yield. They are used on K & R No. 7 Levelers as roll neck bearings on the 11 power driven main leveler shafts and on the pair of adjustable pinch roll shafts that guide entry of alloy steel bars up to 1" thick by 8" wide.

Shown are the matched GUIDEROL bearings in their roll neck mountings. Driven through universal joints at 38 to 114 RPM, the power rollers, supported at each end by pressure lubricated GUIDEROL bearings, provide production speeds of 70 to 210 feet per minute.

Kane and Roach uses GUIDEROL bearings in many applications with complete assurance of extra capacity and dependable performance with minimum maintenance.

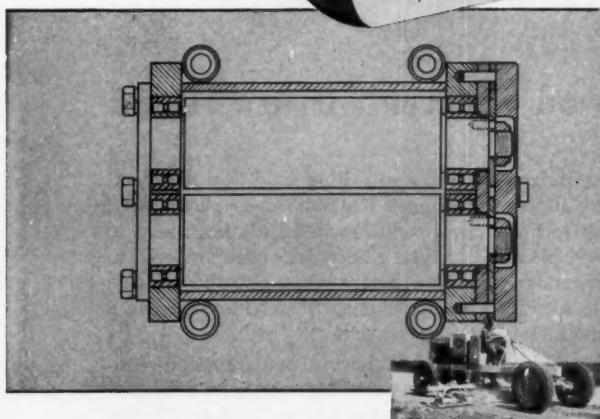
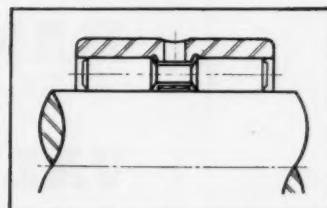


WRITE TODAY FOR FREE McGILL BEARING CATALOG
No. 52-A for complete data on McGILL GUIDEROL, CAMROL,
MULTIROL and CAGEROL BEARINGS.



GUIDEROL BEARING

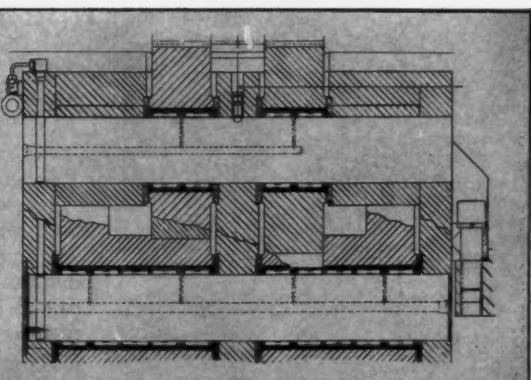
Cutaway to show center guided roller principle



GUIDEROL BEARINGS WITHSTAND VIBRATION IN LIMA ROADPACKER APPLICATION

GUIDEROL bearings support the off-balance rotors which produce vertical vibration in the six vibrator assemblies of each LIMA ROADPACKER machine. The drawing shows the position of 4 rotor support bearings. A gear motor drives the rotors which are one-half filled with lead to produce vibration for road compacting.

The user states that GUIDEROL bearings were selected because of high capacity in limited diameter and their ability to withstand extensive off-balance vibration. Possible end floating of the separable bearing fits the design very nicely. Performance is considered most satisfactory as the bearings easily resist the eccentric loading.



GIDDINGS & LEWIS SKIN MILLING MACHINE APPLICATION REQUIRES GUIDEROL RIGIDITY — MINIMUM DEFLECTION

GUIDEROL BEARINGS, IN MATCHED SETS are used to mount the reduction gearing in the table drive gear box of each NUMEROID tape controlled skin milling machine. The drawing shows a partial section of the table drive. GIDDINGS & LEWIS MACHINE TOOL CO. cites excellent performance of the GUIDEROL bearings. Guided rollers in this bearing have eliminated the problem of having the roller bind on the shaft if slight misalignment is present. The drive assembly mechanism reduces back lash by using a pre-loaded gear arrangement and matched bearings. The bearings are flooded with oil through the center of the shaft. Speeds are 1/30 to 460 RPM.



MULTIROL-GUIDEROL-CAMROL-CAGEROL

McGILL MANUFACTURING CO., INC., Bearing Div.,
200 N. Lafayette St., Valparaiso, Ind.

MICROMETER SETTING

For Exacting Flow Control

HANNA
Flo-Set
VALVES



FOR AIR • OIL • WATER • OTHER FLUIDS

Flo-Set 1000

Hydraulic pressure to 1000 psi
Sizes $\frac{1}{4}$ ", $\frac{3}{8}$ ", $\frac{1}{2}$ ", $\frac{3}{4}$ "
Temperatures to 250°F

Flo-Set

Air, Oil, water operation to 250 psi
Sizes $\frac{1}{4}$ ", $\frac{3}{8}$ ", $\frac{1}{2}$ ", $\frac{3}{4}$ "
Temperatures to 250°F



OTHER HANNA VALVES
Include solenoid, pilot, hand and foot operated types

REGULATING cylinder speeds or controlling fluid flow of air, oil or water is so simple with Hanna Flo-Set Valves... you need only turn the valve body one revolution to adjust from zero to full pipe capacity. Micrometer-type graduations are numbered to indicate the percentage of pipe capacity. Once set, the position can be locked to avoid accidental change. Future resetting to a predetermined flow requires no guesswork.

Hanna Flo-Set Valves allow full flow in one direction—controlled flow in the opposite. Used in pairs, they regulate independently cylinder instroke and outstroke speeds. Hanna Flo-Set Valves assure uniform speed, smoother action and improved performance of cushioned and non-cushioned cylinders.

Valve sizes are $\frac{1}{4}$ ", $\frac{3}{8}$ ", $\frac{1}{2}$ ", and $\frac{3}{4}$ "... a $\frac{1}{4}$ " Jr. model, without graduations or locking collar, is available for light piping and tubing.

Whatever your problem of precision fluid control may be—you will find the best answer in Hanna Flo-Set Valves—designed, built and guaranteed by Hanna's 50 years of experience in hydraulics and pneumatics.

WRITE FOR LITERATURE AND COMPLETE DETAILS,
or consult your classified telephone directory or Thomas' Register for your nearest Hanna representative.

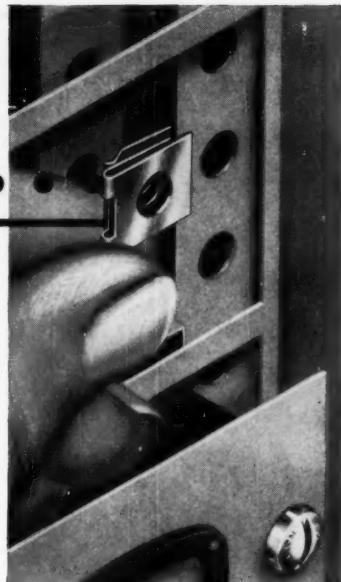
Hanna Engineering Works



HYDRAULIC AND PNEUMATIC EQUIPMENT... CYLINDERS... VALVES

1751 Elston Avenue • Chicago 22, Illinois

NEW.



clip-on
receptacle cuts
1/4 turn fastener
installation
time by 86%

for LION 1/4 turn FASTENERS

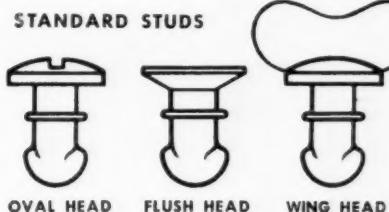
Riveting and welding are eliminated by the new, time-saving clip-on receptacle that just slips over a hole in your door frame and locks itself in place.

The Lion stud is as easily installed. Slipped through a hole in the panel or door, it is captivated by a split ring retainer. Both the stud and receptacle have a generous "float" to tolerate misalignment of parts.

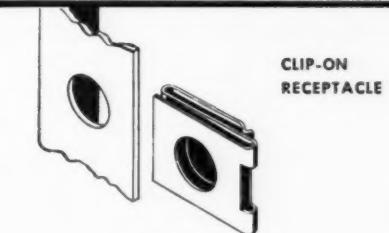
Operation is fast—1/4 turn to lock, 1/4 turn to unlock.

FREE!

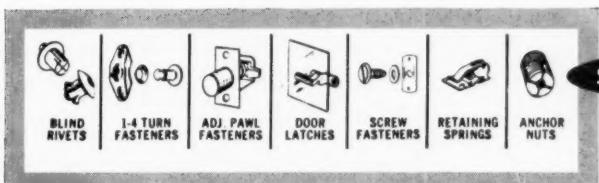
For complete information on this and other fasteners, send for your free copy of Southco Fastener Handbook, Southco Division, South Chester Corporation, 237 Industrial Highway, Lester, Pa.



Material: steel, case hardened
Finish: Cadmium plate per QQ-P-416 Type I Cl. 1.



© 1960



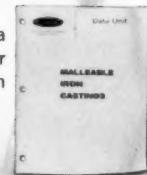
SOUTHCO **FASTENERS**
LION

Tool and Hardware Manufacturers Use Malleable for the Parts They Guarantee...

"Guaranteed Against Warping or Breaking" is the seal of quality often found on tools and hardware made of Malleable iron. Frequently Malleable components are guaranteed while the other materials in the same tools are not.

Proven performance superiority has induced many tool and hardware manufacturers to switch to Malleable castings so they, too, can guarantee their products. At the same time, they often reduce their costs. How? Because Malleable provides more strength per dollar than any other metal; Malleable is the most machinable of all ferrous metals of similar properties; Malleable is truly outstanding for its toughness, ductility, castability and corrosion resistance. While Malleable's natural appearance is attractive, a wide variety of finishes can be applied for added customer appeal.

Improve your products by using Malleable castings. Check with any Malleable producer that displays this symbol —



Profitmaking Ideas are yours free in our Data Unit No. 114, available from any member foundry, or Malleable Castings Council, Union Commerce Building, Cleveland 14, Ohio.



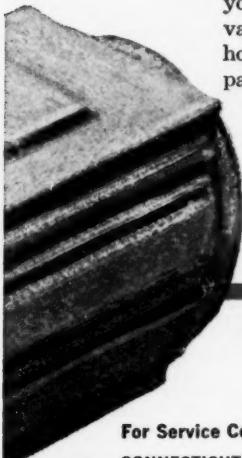
The manufacturer of this unit converted his entire line of machinist vises to Malleable...then guaranteed them against breakage. Not one claim has been made in three years!

\$10,000 per year are saved by the manufacturer of this hydraulic jack since he converted the 16 inch long caster bar to a Malleable casting. The bar originally was a fabricated part that required shearing, punching, sawing, chipping, grinding and reaming, plus welding at eight points. The Malleable casting is delivered ready-to-use at a savings of \$2.68 per unit.



The wide range of Malleable's properties permits its use in hundreds of tool and hardware applications. Besides the examples shown here, Malleable is used for load binders, chain hoists, hinges, many kinds of clamps, pliers, trailer hitches, jack screws, gun frames, fence fittings, casters, brackets and pipe threading and cutting tools.

When you're interested in high quality and long life, Malleable gives your products many competitive advantages. We'll be glad to show you how. Write or call one of the companies listed below.



For Quality and Economy...Use

For Service Contact...

CONNECTICUT

Connecticut Mall. Castings Co., New Haven 6
Eastern Malleable Iron Co., Naugatuck

DELAWARE

Eastern Malleable Iron Co., Wilmington 99

ILLINOIS

Central Fdry. Div., Gen. Motors, Danville
Chicago Malleable Castings Co., Chicago 43
Moline Iron Works, Moline
Moline Malleable Iron Co., St. Charles
National Mall. and Steel Castings Co., Cicero 50
Peoria Malleable Castings Co., Peoria 1
Wagner Castings Company, Decatur

INDIANA

Albion Malleable Iron Company, Muncie Division, Muncie
Link-Belt Company, Indianapolis 6
National Mall. & Steel Castings Co., Indianapolis 22

IOWA

Iowa Malleable Iron Co., Fairfield

MASSACHUSETTS

Belcher Malleable Iron Co., Easton

MICHIGAN

Albion Malleable Iron Co., Albion
Auto Specialties Mfg. Co., Saint Joseph
Cadillac Malleable Iron Co., Cadillac
Central Fdry. Div., Gen. Motors, Saginaw

MINNESOTA

Northern Malleable Iron Co., St. Paul 6

MISSISSIPPI

Mississippi Malleable Iron Co., Meridian

NEW HAMPSHIRE

Laconia Malleable Iron Co., Laconia

NEW YORK

Acme Steel & Mall. Iron Works, Buffalo 7
Frazer & Jones Company Division
Eastern Malleable Iron Co., Solvay
Oriskany Malleable Iron Co., Inc., Oriskany
Westmoreland Mall. Iron Co., Westmoreland

OHIO

American Malleable Castings Co., Marion
Central Fdry. Div., Gen. Motors, Defiance
Dayton Mall. Iron Co., Ironton Div., Ironton

MALLEABLE

Dayton Mall. Iron Co., Ohio Mall. Div., Columbus 16
National Mall. and Steel Castings Co., Cleveland 6

PENNSYLVANIA

Buck Iron Company, Inc., Philadelphia 22
Erie Malleable Iron Co., Erie
Lancaster Malleable Castings Co., Lancaster
Lehigh Foundries Company, Easton
Meadville Malleable Iron Co., Meadville
Pennsylvania Malleable Iron Corp., Lancaster

TEXAS

Texas Foundries, Inc., Lufkin

WEST VIRGINIA

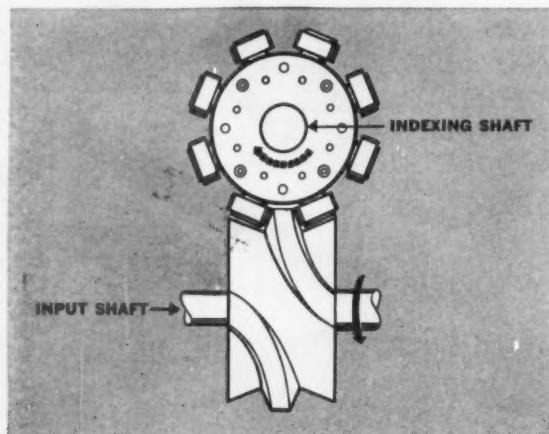
West Virginia Mall. Iron Co., Point Pleasant

WISCONSIN

Belle City Malleable Iron Co., Racine
Chain Belt Company, Milwaukee 1
Federal Malleable Company, Inc., West Allis 14
Kirsh Foundry Inc., Beaver Dam
Lakeside Malleable Castings Co., Racine
Milwaukee Malleable & Grey Iron Works, Milwaukee 46

How Ferguson *ELIMINATES BACKLASH* in Index Tables

Backlash in indexing results in shock loads that affect the efficiency of a machine and the quality of its product. Most indexing mechanisms have inherent characteristics that cause backlash and poor dynamic conditions and prevent the designer from taking full advantage of modern feeds, tooling and methods that contribute to production economy.

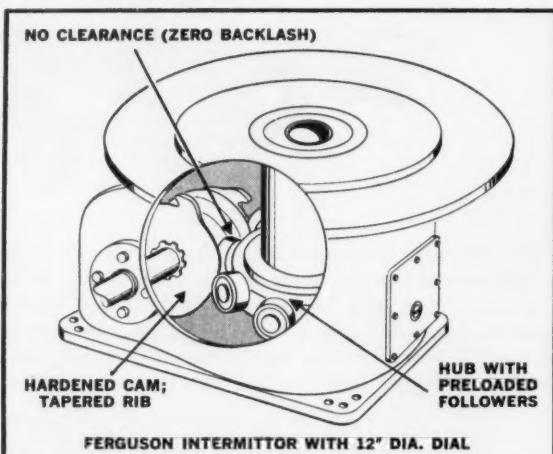


Ferguson Intermittor Index Tables have inherent zero backlash and extreme precision which results in a rotary transfer machine base capable of operating speeds up to 500 indexes a minute. *A Ferguson index table never proves to be a limiting factor in the speed or performance of an automatic assembly machine.*

HERE'S WHY: The continuously rotating cam of a Ferguson indexing mechanism features a *tapered rib* along which two preloaded bearing followers roll, maintaining constant contact with no clearance between them and the rib. When the mechanism is in the rest, or dwell, position, a straight portion of the rib locks the followers with zero backlash and an indexing accuracy of .001". Wear on the hardened tool steel cam is infinitesimal (many have been in use for more than 25 years). Followers are rated for a minimum of 8,000 hours opera-



tion. If backlash occurs after this period the life of the drive may be renewed merely by replacing the standard followers.



Compare this with other types of indexing devices. A geneva drive, with its slotted wheel and driver, and a barrel cam with a grooved track which engages one follower at a time, must have clearance in the slot or groove to allow passage of the follower. The slightest amount of clearance causes backlash. As the slot or groove wears, the clearance becomes greater and the backlash condition worsens. At the higher, more profitable operating speeds poor dynamics cause wear on other parts of the machine. The user must choose between frequent downtime for repairs or slower speeds . . . He is the loser in either case.

FREE DESIGN DATA — Load ratings, dimensions and application and installation information about standard and stock Intermittors, Ferguson Drives and in-line machines are contained in a single 36 page catalog. Every designer should have one in his library . . . Write Ferguson—Ask for Catalog No. 160.

**FERGUSON
MACHINE CORPORATION**

A subsidiary of Universal Match Corporation

7818 Maplewood Court

St. Louis 17, Missouri

WEAR RESISTANT
THOMSON

60 Case

AVOID the HIGH COST
and difficulty of fabricating
long, hard & straight
parts by
conventional
methods!

hardened and ground

SHAFTS, ROLLS, GUIDE RODS and other long-round parts

ELIMINATE WEAR and REDUCE COST

60 Case is the result
of over 15 years of experi-
mental work and production experi-
ence with hardened and ground shafts
which are a requirement for BALL BUSHINGS,
the Linear Ball Bearing manufactured by
Thomson Industries, Inc.

The special techniques and equipment that have been developed enable high production rates and low handling costs. This permits big savings over conventional methods which are plagued with erratic warpage, straightening and resultant grinding problems. Finished 60 Case parts frequently cost less than the scrap losses that result from conventional methods.

60 Case material has a surface hardness close to 60 on the Rockwell C scale which is essential to resist wear.

Long lengths of material ranging in diameter from $\frac{1}{4}$ " to 4" are stocked to enable prompt shipment of 60 Case parts, with or without special machining. Write for literature and name of your local representative.

For emergency needs call collect
Manhasset 7-1800

ADVANTAGES of 60 Case

- COST REDUCTION
- GROUND FINISH
- HARD BEARING SURFACE
- STRAIGHT PARTS
- NICK- & DENT-PROOF
- DELIVERY FROM STOCK
- ACCURATE DIAMETERS
- ADDED STRENGTH
- UNIFORM HIGH QUALITY

TYPICAL 60 Case PARTS

GUIDE RODS • SHAFTING • ROLLS • TRAVERSE RAILS
PISTON RODS • ARBORS • LEADER PINS • TIE RODS
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MANDRELS • BEARING ROLLERS • SPINDLES

THOMSON INDUSTRIES
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Dept. C-5, Manhasset, New York

Circle 448 on Page 19

PARTS HARDENED to 60 C...

increase life...reduce cost!

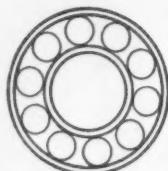
Reduce Bearing Space— Increase Bearing Life on heavily-loaded applications!

ORANGE *STAGGERED* ROLLER BEARINGS

with the unique STAGGERED ROLLER DESIGN



By using many short rollers in staggered arrangement instead of fewer long rollers as in conventional bearings, Orange "Staggered" Roller Bearings provide outstanding advantages for heavy-duty, highly-stressed and precision applications. They do the work of larger straight roller bearings—save space, weight and cost—assure long, trouble-free operation.



End views of "Staggered" roller bearing (top) and conventional bearing, show how many short rollers distribute the load over a multiplicity of contact points within the loaded zone.

- **Reduced Roller Skewing.** Short Orange rollers can skew only a fraction of longer rollers for a given angular misalignment. Short rollers align themselves independently, whereas longer rollers skew along their full length.
- **Better Fatigue Life** because short rollers greatly reduce damaging effects of edge loading, compared with long trunnion or cylindrical rollers, when dimensional deviations of parts or uneven loading are encountered.
- **Run More Smoothly** because closer centers of staggered rollers have half the chordal distance of conventional bearings. Especially valuable in printing, or rolling steel or foil.



"Staggered" Bearing ends trouble in Rod Mills

Converting to Orange "Staggered" Roller Bearings in the pinion stands of its rod mills, Washburn Wire Company, Phillipsdale, R. I. eliminated periodic bearing replacements and high lubrication costs. Operating 24 hours a day under tremendous loads, the "Staggered" bearings have remained maintenance-free for over 3 years. Washburn engineers say the change-over paid for itself in one year.

- Orange "Staggered" Roller Bearings are available in a complete range of sizes interchangeable with other bearings in the 200 and 300 series.

WRITE FOR ENGINEERING MANUAL M-59

ORANGE
ROLLER BEARINGS

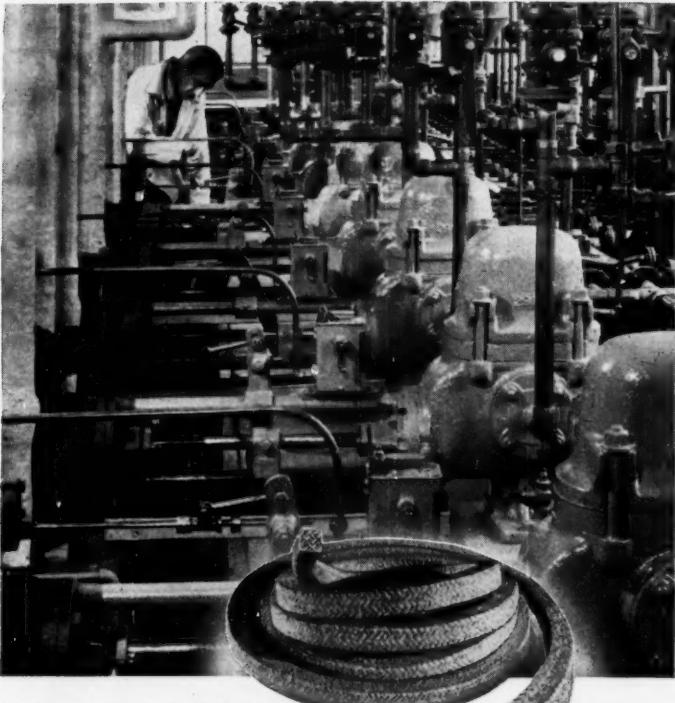
ORANGE ROLLER BEARING CO., Inc.
556 Main Street, Orange, N. J.

Needle Bearings — Staggered Roller Bearings
Journal Roller Bearings — Thrust Roller Bearings
Cam Followers





ENGINEERED TEFLON PRODUCTS



Apply Garlock 5875 Teflon-impregnated Packing to centrifugal and rotary pump shafts, valve stems and expansion joints, and reciprocating rods, rams, and plungers . . . a premium packing at regular packing prices.



GARLOCK

Garlock sales offices and warehouses throughout the U.S. and Canada. Or, for more information, write for Catalog AD-185, Garlock Inc., Palmyra, New York.

Canadian Div.: Garlock of Canada Ltd.
Plastics Div.: United States Gasket Company

Order from the Garlock 2,000 . . . two thousand different styles of Packings, Gaskets, Seals, Molded and Extruded Rubber, Plastic Products.

*DuPont Trademark for TFE Fluorocarbon Resin
†Registered Trademark

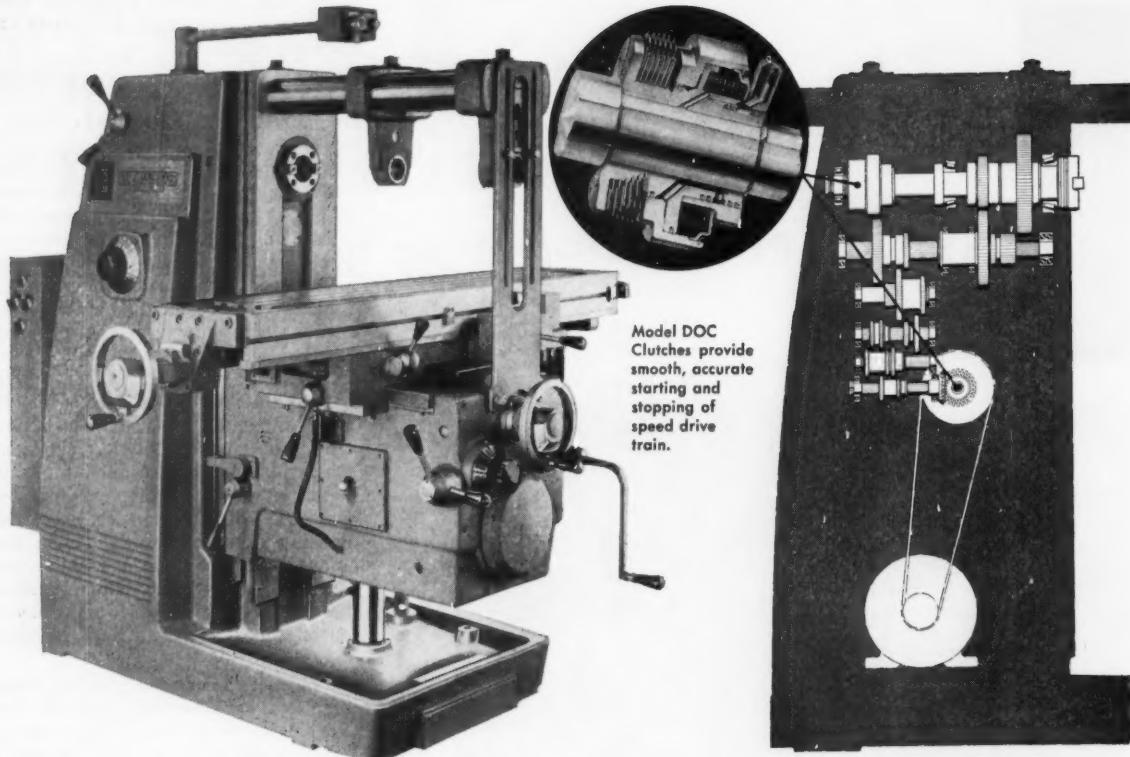
NOW—YOU CAN BUY GARLOCK TEFLON® PUMP PACKING AT REGULAR PACKING PRICES!

Through an improved manufacturing technique, Garlock offers a Teflon-impregnated LATTICE BRAID[†] Packing at a reduction of approximately 40% over the price of similar competitive packing. Designated Garlock 5875, this packing can be purchased at prices comparable to regular packing.

Enjoy premium benefits without a premium price. Garlock 5875 offers a high Teflon content—more than 30% by actual weight—for greater protection, reduced wear. In temperatures from -90° F to +500° F, Teflon-impregnated LATTICE BRAID Packing is recommended for use against moderately destructive and corrosive mineral acids and caustics. For more destructive and corrosive applications, Garlock 5888 Teflon-treated fiber packing is recommended. Teflon, too, is as "frictionless" a material as you will find; this greatly reduces wear to the packing itself, and to any moving parts that it contacts during normal operation.

Specialized construction provides longer life, less maintenance. Garlock 5875 Packing is made from Teflon-impregnated white asbestos yarn, woven in the superior LATTICE BRAID construction. Here, each strand of treated yarn is intertwined at a 45° angle through the packing body. This completely integrates the structure for greater strength and, unlike ordinary square or round braid, eliminates individual *layers* of yarn—layers that, once worn through, destroy the usefulness of the packing. Without a layer or single outer braid to wear through, LATTICE BRAID remains unified without disintegrating far beyond the limits of other packings.

Enjoy fast delivery from warehouse stock. Garlock 5875 Packing is immediately available in sizes from $\frac{1}{4}$ " through $\frac{5}{8}$ " in either spool or reel form to meet your specific needs; also available on order in ring form in these sizes. Specify now from your local Garlock representative at the nearest of the 26



In Kearney & Trecker Milling Machine . . . **Twin Disc Oil-Actuated Clutches** help make spindle drive a model of compact efficiency

There's no "gingerbread" on Kearney & Trecker's model 205 S-12 Milling Machine; unessential parts have been ruthlessly purged. But the observant eye can see skillful, meticulous engineering in the smallest detail of this unit. Everything is geared to functionalism—to the objectives of simplicity, efficiency and ease of operation.

The 205 S-12 offers a wide range of speeds for virtually all metal removal jobs—20 to 1600 rpm range with 24 changes at 5 hp. With the many attachments available, this knee-type machine can do just about everything but sign the operator's paycheck.

Especially impressive in the 205 S-12 design is the speed drive train.

It's amazingly compact, yet sturdy and quiet-running. Because positive starting and fast braking from high speeds call for high-energy clutches, Kearney & Trecker chose two Twin Disc DOC Oil-Actuated Clutches to handle these functions.

The ability to absorb high-energy loads makes the multiple-plate DOC Clutch unique. In addition to providing a high friction coefficient, the sintered metallic facing on the clutch plates prevent "welding" with consequent scoring. And oil actuation assures high clamping force with no wear adjustments necessary.

These features make for remarkably compact size in relation to capacity. The clutches used in the 205

S-12 machine, for example, are only 5" in diameter.

Model DOC Clutches transmit up to 137 hp and up to 690 lb-ft of torque. Twin Disc engineers can show you how these oil-actuated clutches can be profitably applied to your machines. Literature on request. **TWIN DISC CLUTCH COMPANY**, Racine, Wisconsin. *Hydraulic Division*, Rockford, Illinois.



TWIN DISC
Friction Clutches and
Fluid Drives

when
it
comes
to
your
product's
reputation...

**DON'T
PUSSYFOOT!**

*The new symbol
of Shakeproof quality in action!*



ORDER A SHAKEPROOF SAMPLE KIT . . . prove superior Live Action locking yourself. Includes washer test samples and booklet with test data, information on all washer sizes and types including custom-designed "Specials". Write for yours.

Demand genuine Shakeproof® Live Action Lock Washers—never accept a substitute! It just doesn't pay off. As a matter of fact, anything less than Shakeproof quality may pay you back in dissatisfied customers, lost business, extra service time and factory rework.

Live Action takes the risk out of fastenings. Shakeproof's exclusive 3-way combination of multi-toothed line bite . . . built-in spring reaction that holds harder under stress . . . and bracing strut action—rigidly opposes loosening—assures a permanent fastening.

Test-after-test proves Shakeproof Live Action locking superiority. You can prove it, too! Order a Shakeproof Sample Kit—we'll send you a selection of Shakeproof Lock Washers to test as you see fit.

Don't pussyfoot . . . make tracks to Shakeproof for the lock washer that never compromises your product's reputation.

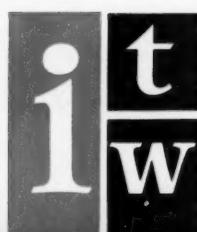


SHAKEPROOF "FASTENING HEADQUARTERS"

DIVISION OF ILLINOIS TOOL WORKS • St. Charles Road, Elgin, Illinois
In Canada: SHAKEPROOF/FASTEX, Division of Canada Illinois Tools Ltd.
67 Scarsdale Road, Don Mills, Ontario

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Circle 452 on Page 19





Born to live a short life,
this missile guidance component
must perform as if it had to last forever!
CDF molded this part under high
pressure from glass fabric epoxy
laminate to meet rigid military
electro/mechanical requirements.

Result: a panel with excellent
electrical insulating properties and
high mechanical strength that provides
significant savings in space and weight,
helps minimize vibration.



CONTINENTAL-DIAMOND FIBRE

CONTINENTAL-DIAMOND FIBRE CORPORATION, NEWARK, DELAWARE • A SUBSIDIARY OF THE  COMPANY

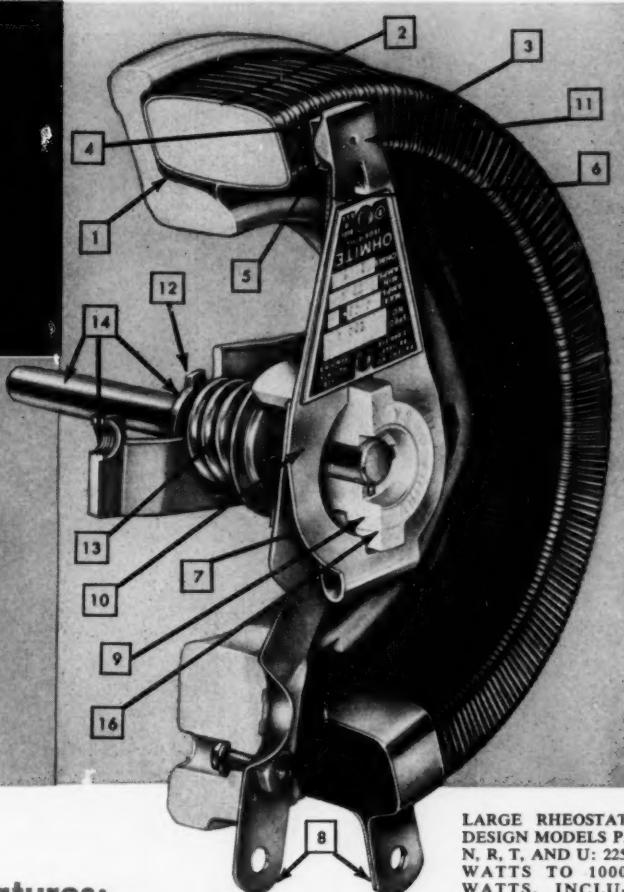
OHMITE



RHEOSTATS

NOW 11 Sizes! 12½ to 1000 Watts

Ohmite offers you industry's most complete line of rheostats. All sizes are available from stock in a wide range of resistance values, including the NEW Model "E." Ten sizes are available to meet MIL-R-22A requirements in *each* of the 26 type designations.



LARGE RHEOSTAT
DESIGN MODELS P,
N, R, T, AND U: 225
WATTS TO 1000
WATTS, INCLU-
SIVE. OTHER MOD-
ELS ARE SIMILAR.

16 Quality Engineering Features:

1. Vitreous enamel bonds the core and base together into one integral unit.
2. The wire is wound over a solid porcelain core, and each turn is locked against shifting by vitreous enamel. Uniform or tapered winding.
3. Close graduation of control. Each turn of wire is a separate resistance step.
4. Large, flat surface upon which the contact brush rides.
5. Metal-graphite contact brush (varied to fit current and resistance) insures good contact, with negligible wear on the resistance wire.
6. Shunt pigtail of ample size carries the current directly to the slip-ring.
7. Large slip-ring of high-current carrying
- ability minimizes mechanical wear and provides connection from the moving contact to the terminal.
8. Potentiometer use. The rheostats are provided with three terminals so they can be used as potentiometers or voltage dividers.
9. High strength ceramic hub insulates the shaft and bushings from all live parts. All sizes will stand a 3000 volt a-c breakdown test to ground.
10. The contact arm is a long tempered steel spring which assures uniform contact pressure at all times. Cadmium-plated for corrosion resistance.
11. Rounded pivot holds contact brush in flush-floating contact with wire.
12. Stops which are keyed to the shaft and
- base limit the rotation—thus no torsional strain is imposed on the contact arm on stopping.
13. Compression spring maintains uniform pressure and electrical contact between slip-ring and center lead at all times.
14. Models E, H, J, G, K, and L: End-thrust is taken by a retaining ring. Models P, N, R, T, and U: End-thrust is taken by a stop washer. Steel shaft in brass bushing provides a wear-resistant, wobble-free bearing.
15. Ohmite rheostats meet requirements of NEMA and EIA (formerly RETMA).
16. There are only ceramic and metal in the construction of Ohmite rheostats—there is nothing to char, burn, shrink, or deteriorate.

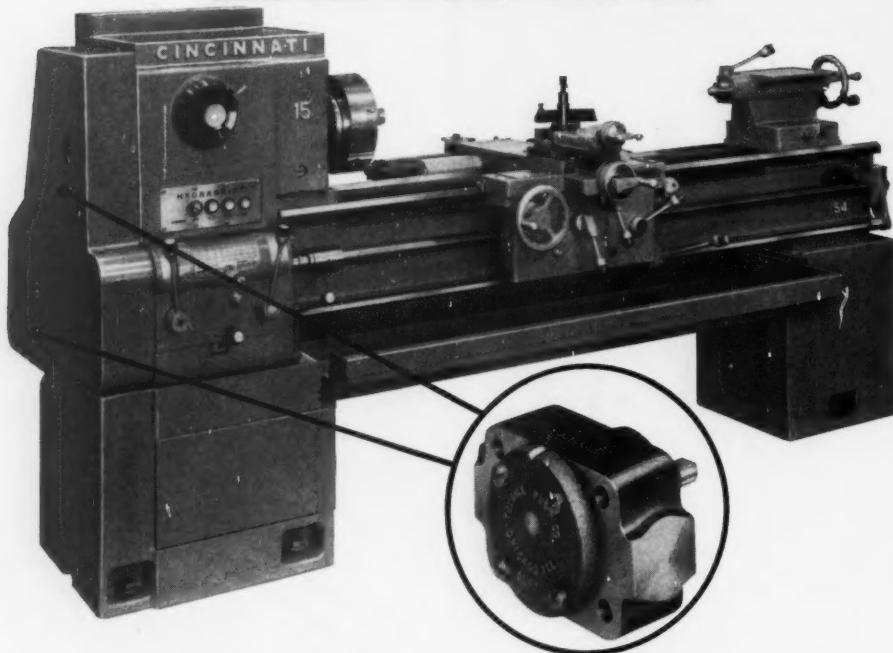
Write on company letterhead for Catalog 58.

OHMITE

MANUFACTURING COMPANY
3618 HOWARD STREET
SKOKIE, ILLINOIS

RHEOSTATS • RESISTORS • TAP SWITCHES
RELAYS • R.F. CHOKES • TANTALUM CAPACITORS
VARIABLE TRANSFORMERS • GERMANIUM DIODES

Another pump problem . . . solved by TUTHILL



TUTHILL PUMPS For Hydraulics, Lubrication in New Cincinnati Hydrashift Lathes

Cincinnati's new Hydrashift lathes use hydraulic power instead of muscle for spindle speed shifting. Entirely new from headstock to tailstock, these dependable units reflect in every way the quality and reliability long associated with this leading machine tool manufacturer.

Cincinnati selected Tuthill pumps for two vital assignments . . . to provide hydraulic power for Hydrashift preselective speed shifting . . . and for positive pressure lubrication of the entire unit. Minor modifications of a standard Tuthill cartridge pump, Series RFD, enable it to meet the requirements of both applications . . . providing interchangeability and allowing incorporation of both units with the greatest possible ease on Cincinnati's assembly line.

Wide Selection Available From Stock

Tuthill's versatile and dependable cartridge pumps have been used for hundreds of applications . . . both as OEM components and for

maintenance. Their compactness solves design problems . . . for example the Model RFD above measures only $4\frac{1}{4}$ " by $2\frac{1}{2}$ " by $3\frac{15}{16}$ " including shaft. Moderate prices and immediate availability from stock minimize inventory problems, result in significant savings.

Cartridge pumps can be supplied for capacities from 55 to 360 gph at 1800 rpm. They are available with or without Tuthill's special reversing feature which allows them to be driven from reversing shaft or for nondirectional service. They may be supplied with internal or external porting . . . or with variations of both. Three different standard shaft modifications are offered and many more are available.

Send today for Catalog 100 which gives complete details . . . or send information on your particular application so Tuthill's engineers can indicate ways in which a Tuthill pump can save you money.

Tuthill manufactures a complete line of positive displacement rotary pumps in capacities from 1 to 200 gpm; for pressures to 1500 psi; speeds to 3600 rpm.

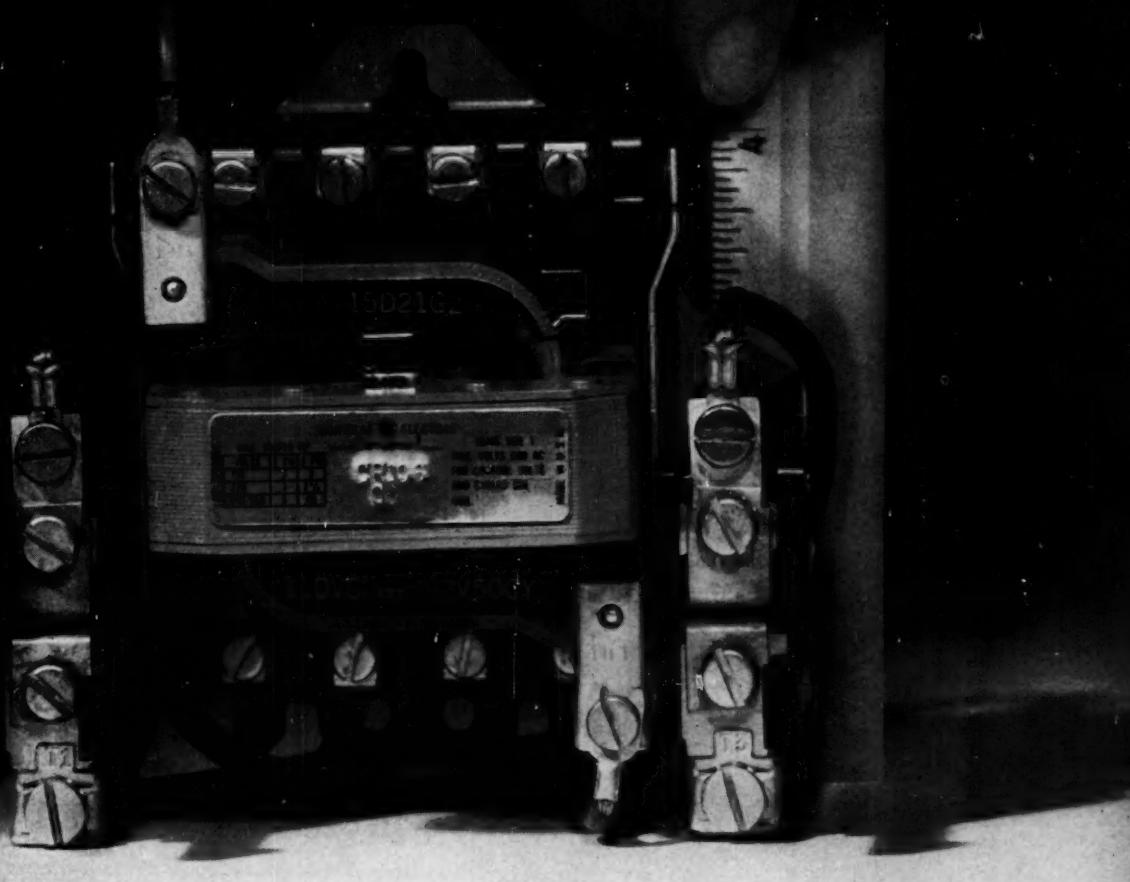


TUTHILL PUMP COMPANY

953 East 95th Street, Chicago 19, Illinois



Height overterminals of General Electric Size 1 magnetic starter is only 4½ inches—shortest of all leading makes.



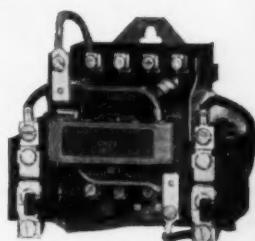
Measure the Space Savings Yourself

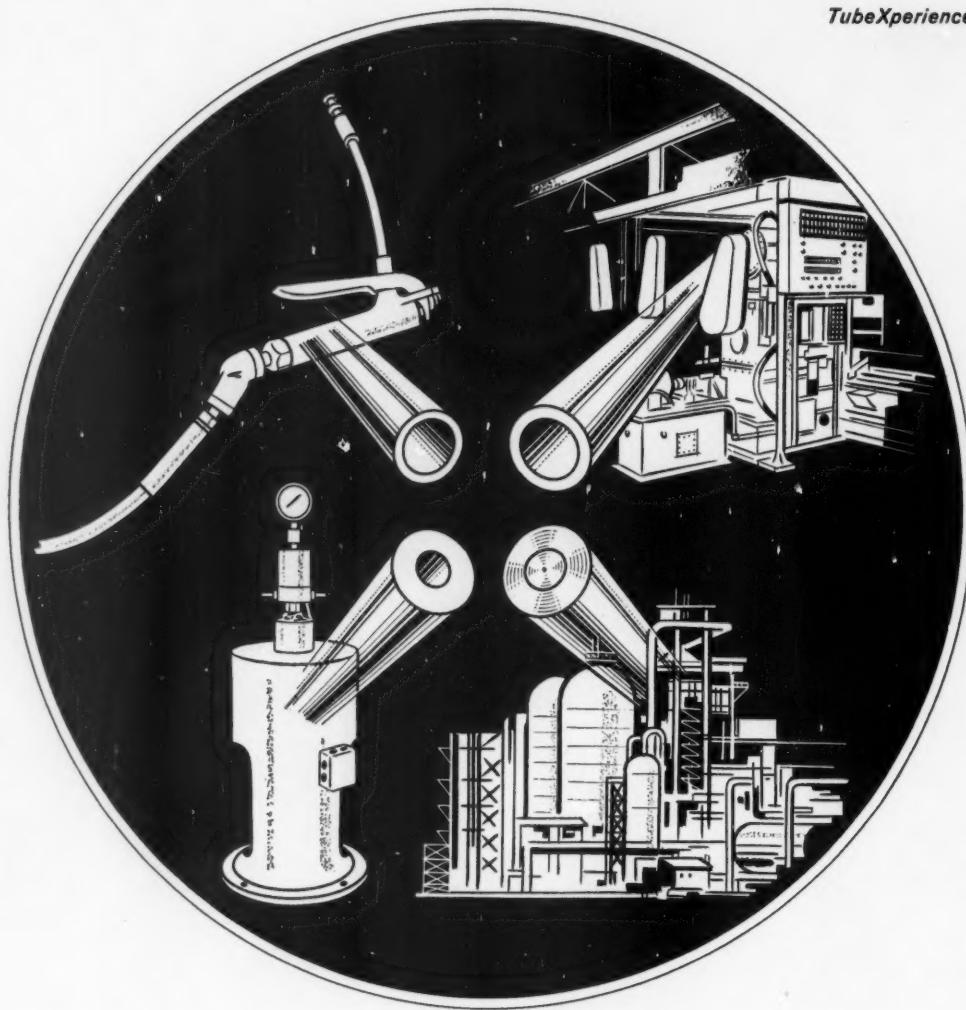
This General Electric Size 1 Magnetic Starter saves as much as two inches of panel space, compared to other leading makes. Using these smaller G-E starters, you can reduce your panel sizes, with resultant savings in labor and material costs. It is often possible to use a standard enclosure where previously a larger, more costly special was required; or to make the panel an integral part of the machine instead of mounting it separately. Your G-E sales representative or distributor can show you other **MEASURABLE ADVANTAGES** of G-E magnetic starters. Call him soon, or write for Publication GEA-7020. Section 811-16, General Electric Company, Schenectady, N. Y.

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Circle 455 on Page 19





Superior tubing makes pressures behave

whether 125, 5000, 30,000 or 100,000 psi

Superior small-diameter tubing makes pressures behave whether low, medium, high or super. Superior pressure tubing can be roughly divided into two groups: commercial pressure tubing for use in a range up to 20,000 psi; premium super pressure tubing to handle pressures from 15,000 to 100,000 psi. Both ranges can be handled effectively by a number of different analyses, depending on service requirements. Typical applications for Superior general-purpose pressure tubing include pressure tools, machine tools, heat exchangers and condensers. Superior super-pressure tubing is found in hydrogenation process equipment, high-pressure autoclaves, and pilot plant installations in chemical and oil refining plants.

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We can probably help you with any tubing problem that may confront you . . . in pressure, super-pressure or other applications. Contact us and feel no obligation. Superior Tube Company, 2010 Germantown Ave., Norristown, Pa.

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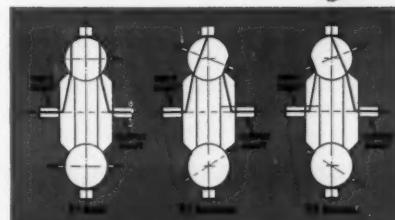
Write today for free Bulletin K-200 containing detailed description, photographs, sectional drawings, rating tables and specifications.

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Internal or external rings provide positive positioning or retaining for light thrust applications.



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Available in varied thicknesses—3 standard series to choose from including the NAS 669/670 "deep groove" series.



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Minimize dynamic balancing problems on shafts with statically balanced rings—make ideal oil slingers.



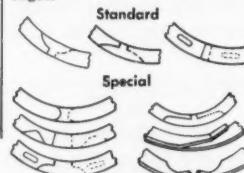
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Single turn, high tensile strength rings greatly strengthen groove.



REMOVAL NOTCHES

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Rings can be supplied with removal notches, slots, tabs, or hooks—round, square, bevelled or tapered edges.



Spirolox Rings have no lugs or projections—uniform wall allows installation with minimum clearance—no special tools are needed for installation or removal. Prototypes require no special tooling or set-up charges. Spirolox lends itself to deep groove design to withstand greatly increased thrust load. Covered by Government Specifications MIL-R-27426 for usage under Government contracts. Ramco engineers will be glad to work with you on the solution of difficult problems.

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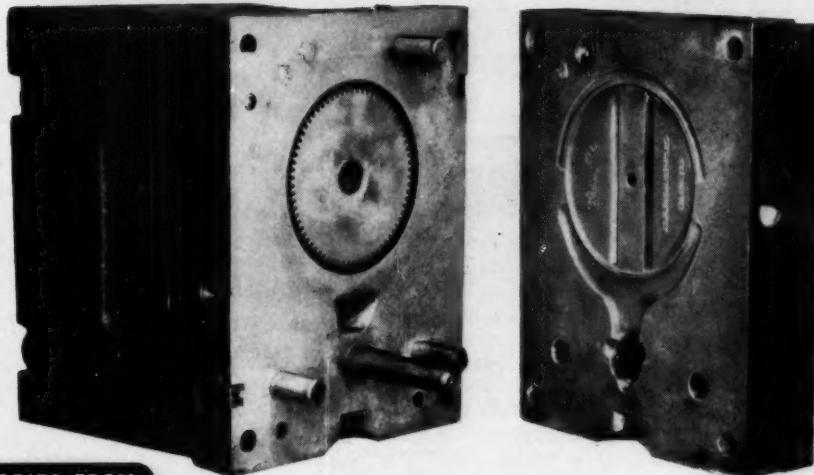
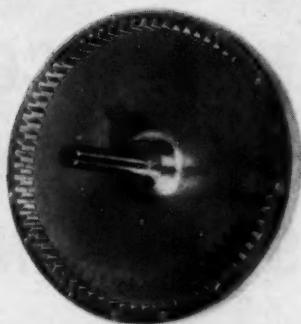


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48 years ago
Mt. Vernon
created this 'movie star'



CASE HISTORIES FROM
MT. VERNON FILES

... and here's why the original die is still performing

Back in 1912 in the days of the nickelodeon when the movie industry was in its infancy, the people who made Simplex theater equipment needed a quality die-casting job. They turned to Mt. Vernon for a die that would turn out the gear end for a hand operated film rewinder.

That was Mt. Vernon's 34th die. Yet even today, 48 years later, the original die continues to turn out these same gears *without a single change*. The movie industry still uses Simplex Film Rewinders, and Cinesound Service Corporation of New York who are the current manufacturers still rely on Mt. Vernon to produce the castings.

The fact is that Mt. Vernon's original die proved itself in actual use . . . despite all the myriad changes in die-casting techniques and

machines since 1912. For our dies are built to give *continuing* top performance . . . backed by the stability and reliability of a firm that is already in its second half-century.

When you are in the market for die castings think first of Mt. Vernon. We have the abilities to make long lasting dies . . . we have the stability and reliability that insure dependable service . . . not for only a year, or ten years, but for 48 years and more if need be. Contact any of our Field Salesmen. They're eager to help you also make a 'Star'.



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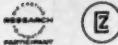


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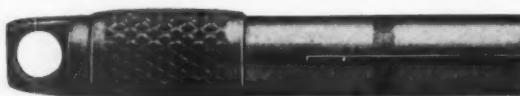
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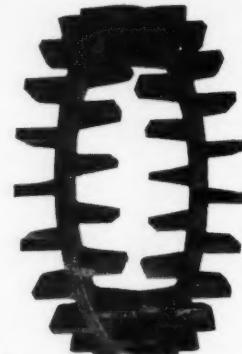
BERYLCO INSPIRES NEW DESIGN THINKING



3½ times actual size

 Electrical connector of beryllium copper rod: By selecting a Berylco alloy, the designer met requirements for high conductivity, corrosion resistance, high contact force, and excellent resistance to creep. The connector also has enough yield strength to permit mis-alignment of the mating connector without loss of electrical contact. It is usable up to 300°F. Lead-in wires can be soft-soldered to the connector.

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 Bearing race cast from beryllium copper ingot: The choice of Berylco alloy on this investment casting was easily made because its high fluidity provides good surface, close tolerances, excellent detail and the ability to cast thin sections. When added to the advantages of the alloy itself, like high strength and good wear resistance, it becomes easy to see why beryllium copper is being used more and more in several casting methods.



Bellows of beryllium copper strip: The design engineer on this part knows a Berylco alloy is a fine choice because its low modulus of elasticity (approx. 18.5×10^6) gives greater deflection for a given pressure change than other high strength alloys. And it has good fatigue strength with a yield strength that gives excellent usable movement range.



THE BERYLLIUM CORPORATION

Reading, Pennsylvania

February 2, 1961



Nothing Venture, Nothing Win

ENGINEERING registration in the fifty states continues to increase. But even the quarter-million or so names now on the rolls represent a minority of qualified engineers.

Total registration is the best index available to the public—and to public officials—of the size of our profession. If we expect recognition as one of the influential professions, wouldn't we have a stronger case if the registration figures matched our true size more closely?

Consulting engineers and engineers employed on public works, like doctors and lawyers, must be registered to stay in business or to hold their jobs. But this incentive doesn't generally apply to engineers working in industry—the big majority.

So, for most engineers personal conviction and individual initiative must replace economic incentive to register.

Two brakes on initiative are pro-

crastination and fear, and we suspect that many engineers, who are convinced and who would like to register, suffer from one or both. Isn't it fear of our own performance or reaction that often prevents our venturing into the unknown or untried situation—like that first public speech, or first airplane ride, or first donation to the blood bank?

Fear of failing the professional engineer examination may be holding back some well-qualified engineers. They don't know exactly what is expected of them or how they will perform. Lloyd Polentz, in his article overleaf, lifts the veil on what to expect.

"Our doubts are traitors, and make us lose the good we oft might win by fearing to attempt." Perhaps Lloyd's article will help resolve the doubts and encourage the attempt.

Colin Carmichael
EDITOR

Are you qualified to get your professional-engineer's license?

Could you pass the state examination?

Chances are you wouldn't have to do much boning up.

**Outlined here are probable content
and range of the exam—
plus sample problems
and suggested study references.**



What to expect in The

LLOYD M. POLENTZ, P. E.
Engineering Consultant
Whittier, California

ENGINEERING registration laws enacted by the 50 states can be a boon to the engineering profession. Protection of the public welfare is the legal justification for registration. Since many designs, operations, or processes undertaken by the engineer today have public implications, engineering comes under the police powers of the state. Legal registration of members of the engineering profession is an exercise of these police powers for the protection of the public health and the public safety.

Such registration gives assurance that only those persons who meet specified educational and experience requirements may practice engineering. Another benefit to the engineering profession is that these laws restrict certain uses of the title "engineer" to those who are legally registered. It is only through registration that the use of the title of engineer can be restricted to those who are qualified to use it.

In recent years, examinations given by the different states have been brought into closer conformity. True, some states give examinations more difficult than others, and the emphasis in different states is not the same. By and large, however, the same general subjects are emphasized and the same types of problems are given. It is possible today to forecast with reasonable accuracy what, in general, the examinee may be confronted with in the funda-



Professional-Engineer Exam

mentals portions of the different state examinations.

There are still two major differences between groups of states. One is that some states make copies of past examinations available and others do not. The other is that some states have closed-book examinations while others are open-book. These practices seem to make little difference in the subject coverage or in the type of problem offered.

To aid engineers who wish to become registered, this article reviews past examination coverage and attempts to forecast future coverage. It itemizes subjects for review to aid the interested engineer to prepare for the first part of the professional engineer examination. Also included are suggested texts for home study.

Content here is based upon review and analysis of the fundamentals portions of examinations as given by 35 different states over a three-year period. Information given applies generally to all of these examinations and probably to all of the fundamentals examinations as given by the different states. It will probably not apply specifically to any one examination given by any one state.

A source of specific information is the state board of registration for professional engineers. In any given state it is the only source of official information.

A correspondence course available from the University of California covers the eight listed subjects. Its purpose is review for the exam.

The subject matter covered in fundamentals examinations can be divided into nine different general categories: Mathematics, mechanics, fluid mechanics, thermodynamics, mechanics of materials, electricity and electronics, chemistry, engineering economics, and physics and miscellaneous. Each of these subjects will be examined. In this discussion, reference to "the examination" will mean the composite of all the examinations reviewed.

Also included is an estimate of the relative emphasis placed on the particular category in the examination. This emphasis has been estimated from the number of problems included in each category in the examinations reviewed, except portions covering physics and miscellaneous which may vary from zero to perhaps 10 per cent in different states.

Mathematics

Relative emphasis 11 per cent

Mathematics must be considered in two lights. First there is that portion of the examination which is devoted to mathematics, per se, and then there is the mathematics required for working the problems

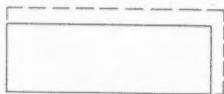
in the other categories. A good working knowledge of algebra, geometry, and trigonometry will be sufficient to solve the bulk of the engineering problems, though some knowledge of calculus is occasionally helpful. That portion of the examination which is devoted exclusively to mathematics covers the range from algebra to calculus.

The algebra requirement includes factoring, solution of quadratic equations, and simultaneous equations. Logarithms and exponents have received a fair amount of emphasis, and the theory and mechanics of logarithmic calculations should be understood. Trigonometry should be reviewed rather thoroughly. Some of the more basic relationships covered are: 1. The signs of the functions in the various quadrants. 2. The definitions of the various functions and their relationships to one another, and the basic right triangles. 3. Law of sines and the law of cosines.

Most of the trigonometry required will be encountered in working problems in categories other than that of mathematics but there are usually a few problems in trigonometry alone. Many examinations also include a surveying problem or two which are primarily problems in trigonometry. Problems in analytic geometry are frequently included.

The calculus requirement includes calculations of maxima and minima, areas, evaluations of indeterminate fractions (the rule of L'Hospital), values of integrals, etc.

Example 1: The length of a rectangle is three times its width. If length and breadth are each increased one ft, the area will be increased 21 sq ft. Find the dimensions of the rectangle.



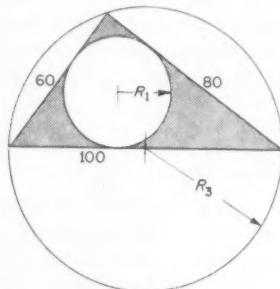
Example 2: Find M if

$$\log_5 M = \log_{25} 4$$

Example 3: Solve by logarithms

$$X = 5.29 (0.896)^{0.435}$$

Example 4: The sides of a certain triangle are 60 in., 80 in., and 100 in. Calculate: a. The radius of the inscribed



circle. b. The radius of the circumscribed circle. c. The area of space outside the inscribed circle but included in the triangle.

Example 5: The equation of a parabola is

$$y^2 = 16x$$

Find the equation of a chord through the points on the curve whose abscissas are 1 and 4 and whose ordinates are positive.

Example 6: A cylindrical tank having a flat top and bottom is to have a capacity of 10,000 cu ft. What should be its diameter and length if the surface area is to be a minimum?

Example 7: If x approaches zero in the expression

$$y = \frac{5x^3 - \cos x + e^x}{x^2 + 2x}$$

then what does y approach as a limit?

Mechanics

Relative emphasis 23 per cent

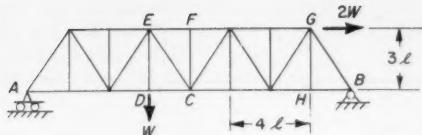
Mechanics is ordinarily weighted the heaviest of all the subjects covered. The material covered can be divided into three general subdivisions—statics, friction, and dynamics.

Statics: The summation of all forces and of all moments must equal zero. These conditions are both necessary and sufficient. A very helpful relationship to keep in mind is that any three forces which are in equilibrium must be coplanar and must also be either parallel or concurrent. If there are four or more forces, use resultants to reduce the number of forces acting to three. A sketch will usually be of considerable help both as a rough check and to clarify the method of analysis. Truss problems are common in this category and the applicant should be acquainted with both the method of sections and the method of joints.

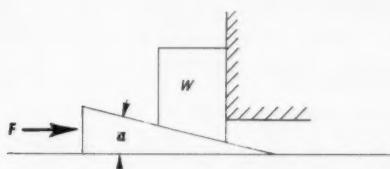
Friction: Friction problems cause so much trouble that the subject is being considered separately. If the concept of friction angle is applied to the friction problem and the equivalent frictionless system constructed it can be treated by the methods of statics and usually solved with no great difficulty.

Dynamics: The applicant should remember the basic equations of motion, Newton's first law, the formula for normal acceleration of a revolving body, and the momentum relationships. In dynamics, the application of the d'Alembert principle permits a problem in dynamics to be reduced to a problem in statics and simplifies the solution considerably.

Example 1: Vertical force W acts at point D and horizontal force $2W$ acts at point G on the truss shown. Assume that all joints are pinned and that points A and B are at the same elevation. Determine the reactions at A and B . Also determine the forces in members EC , EF , FC , BG , and BH , and whether they are in tension or compression.



Example 2: What force F is required to move weight W , where $W = 2000$ lb; $\alpha = 15$ deg; $\mu = 0.20$ for all surfaces.



Example 3: A golf ball leaves the tee at an angle of 30 deg with the horizontal and at a speed of 100 ft per sec. Neglecting air resistance, how far will it travel in a horizontal direction?

Fluid Mechanics

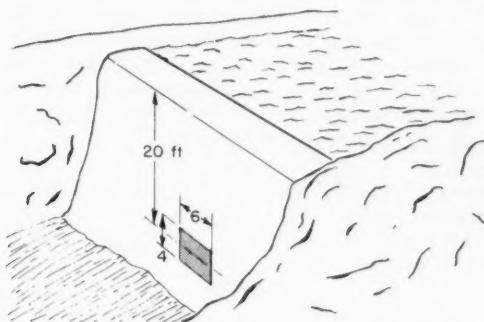
Relative emphasis 14 per cent

Bernoulli's equation is perhaps the most important single relationship in fluid mechanics.

Archimedes principles of buoyancy and the location of the center of pressure are also of importance. The examination is apt to call for knowledge about friction loss in a pipe line as well as hydraulic radius, Reynolds Number, and the Manning equation for open channel flow.

Example 1: A venturi meter with an 8-in. throat is installed in a 12-in. diam horizontal water line. When a mercury manometer shows a 6-in. differential height in the mercury level between the upstream tap and the throat tap, what is the flow in gpm? Assume a venturi coefficient of 1.00.

Example 2: What force is acting, and what is the location of the center of pressure, on a vertical rectangular gate whose center is 20 ft below the surface of the water. The gate is located in a dam and is 4 ft high and 6 ft wide.



Example 3: What will be the flow in a rectangular flume 1.00 ft wide carrying water 2.00 ft deep if the flume drops 6 in. every 100 ft. The Manning coefficient is 0.013.

Example 4: If the friction factor in a 6-in. diam pipe is 0.025, how much water will flow through a 1000-ft length of this pipe which leads from a reservoir whose surface is 50 ft above the discharge end? Neglect entrance losses.

Thermodynamics

Relative emphasis 17 per cent

The general energy equation is useful in the solution of thermodynamics problems and should be reviewed. The universal gas law should also be understood as well as the different processes and the commoner cycles, particularly the Carnot cycle.

Relative humidity, wet bulb, and dry bulb-temperatures, and the dew point of air are sometimes mentioned, and problems in heat transfer are often included. The differences between the three types of heat transfer should be reviewed and the general heat-transfer equation remembered.

Example 1: A centrifugal compressor pumps 100 lb of air per minute from 14.7 psia and 60 F to 50 psia and 270 F by an irreversible process. The temperature rise of 50 lb per min of circulating water about the casing is 12 deg. What horsepower is required? Neglect any changes in kinetic energy.

Example 2: It is desired to obtain a lifting force of 2 tons in a balloon when the atmosphere is at 50 F and 14.7 psia and when the gas in the balloon is at atmospheric pressure but at a temperature of 65 F. a. How many cu ft of helium would be needed? b. How many cu ft of hydrogen?

Example 3: Draw a pressure-volume diagram and a temperature-entropy diagram for a Carnot cycle. What is the thermal efficiency if the cycle operates between 900 F and 100 F?

Mechanics of Materials

Relative emphasis 9 per cent

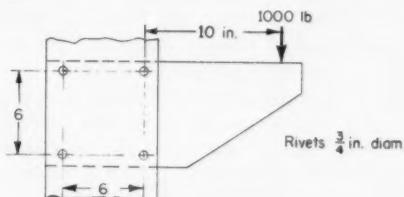
The most important single subject in this section is beam analysis including stress, and shear and moment diagrams. Other important topics are the stress-strain relationship and the relationship for thermal expansion. Problems in torsional stress are also met occasionally.

Rivet problems are relatively common and in these it should be remembered that the total force on each rivet is the vector sum of the force due to the load plus the force due to the resisting moment taken about the centroid of the rivet area.

Example 1: Draw the shear and moment diagrams of the beam shown below.



What is the maximum stress if the beam is 2 in. wide and 6 in. high?



STUDY REFERENCES

The texts recommended are those which the author has found to be of help in those portions of the subjects emphasized in the fundamentals examinations. These are not necessarily the best texts available; no attempt has been made to review all of the available texts.

Mathematics

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General References

21. J. D. Constance—*How to Become a Professional Engineer*, McGraw-Hill Book Co. Inc., New York, 1958.
22. L. M. Polentz—*Engineering Fundamentals for the Professional Engineer's Examination*, McGraw-Hill Book Co. Inc., New York, to be published in 1961.

Example 2: What are the shearing stresses in the rivet section shown (previous page)?

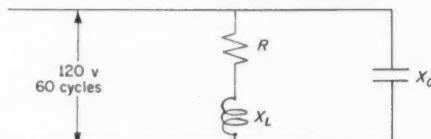
Electricity and Electronics

Relative emphasis 15 per cent

Ohm's law, and internal resistance of batteries and instruments should be understood as well as Kirchhoff's laws and resistances in series and parallel. The applicant should also be able to handle simple L-C-R (inductance-capacitance-resistance) circuit analysis of both series circuits and parallel circuits. It is desirable to be acquainted with the complex-number method of circuit analysis and to review the construction of phasor diagrams. Three-phase circuitry is also encountered occasionally and an applicant should know the difference between line current and phase current, and line voltage and phase voltage. Motor and generator theory should be reviewed to be on the safe side, particularly series and shunt-wound motors.

Example 1: A bank of three transformers is to be connected to reduce the voltage from a three-phase, 12,000-v (line to line) distribution line to supply power for a small irrigation pump driven by a 440-v induction motor. A wye connection will be used for the primary and a delta connection for the secondary. a. What should be the primary voltage of each transformer? b. What should be the secondary voltage rating of each transformer?

Example 2: Find a. Magnitude of the in-phase component of the line current. b. The magnitude of the line current. c. The magnitude of the power delivered to the circuit. d. Draw the phasor diagram.



Example 3: A battery with an emf of 4.0 v and an internal resistance of 0.15 ohms is connected to three 6.00-

ohm resistors in parallel. Connected in series in the circuit is an ammeter with an internal resistance of 0.05 ohms. What current does it read?

Chemistry

Relative emphasis 8 per cent

Balancing equations and determining the weights of reactions are two of the important topics in this section. Dalton's law of partial pressures is also of prime importance. The universal gas law, Avogadro's law, and vapor pressure are other subjects which should be reviewed.

Example 1: What is the composition in volume per cent of the gases obtained from burning FeS_2 with 50 per cent excess air, assuming all the iron goes to Fe_2O_3 and sulfur to SO_2 ?

Example 2: Propane (C_3H_8) is completely burned in air with carbon dioxide and water being formed. a. What is the air-fuel ratio? b. If 15 lb of propane is burned per hour, how many cu ft per hour of dry CO_2 is formed after it has cooled to 70°F at atmospheric pressure?

Engineering Economics

Relative emphasis 3 per cent

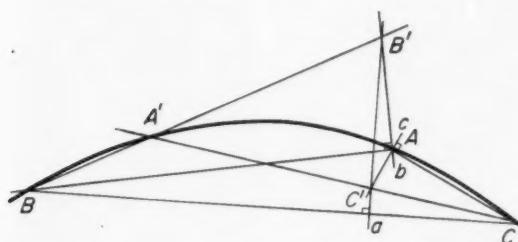
Most of the problems in this category deal with the return from an investment or the cost of a given investment. Some states specify straight-line depreciation and average interest. Others require use of capital-recovery factors or shrinking fund calculations. As a minimum of preparation, it is also advisable to know the compound interest law and how to apply it.

Tips and Techniques

Arc Through Three Points

To draw a circular arc through three points so located that usual construction methods are impractical, use the following point-by-point method.

With A , B , and C as the three given points, through A draw b and c perpendicular to BA and CA , respectively. Draw any perpendicular, a , to BC ; a then intersects b at B' and c at C' . Lines BB' and CC' intersect at a point A' on the required arc. To obtain another point, for example A'' ,



Example 1: A certain type of automatic milling machine can be purchased for \$6500.00. Expert estimates indicate a life of 10 years and \$500.00 salvage for this particular machine. Use the sinking-fund method for depreciation charges and calculate total annual capital recovery charges which include return on capital on this machine when interest is: a. 4 per cent. b. 6 per cent.

Example 2: A steam power plant costs \$1 million now. It has a life expectancy of 40 years, and its estimated salvage value is \$100,000. The operating cost of the plant is \$30,000 per year. At 6 per cent rate of interest what is the annual: a. Straight-line depreciation? b. Average interest on the investment? c. Total cost?

Example 3: How long would it take \$187.00 to double at 6 per cent annual interest: a. Compounded yearly? b. Compounded quarterly?

Physics and Miscellaneous

Most of the physics problems are ones in mechanics, thermodynamics, or another of the categories already covered. Occasionally an examination may also include a problem or two on light, sound, or atomic physics. These are not common, however, and this category is so broad that no specific recommendations for preparation can be made other than to review any good college physics text.

An occasional drafting problem is also included. These are usually problems in projection and a review of descriptive geometry is a good preparation for these.

ACKNOWLEDGEMENT

This article is based upon a portion of the author's forthcoming book, *Engineering Fundamentals for Professional Engineers' Examinations* to be published soon by McGraw-Hill Book Co.

either the construction is repeated using A' instead of A , or line a is repositioned.—PAUL PAYETTE, Montreal, Quebec, Canada.

Multiplying by Pi

To obtain seven-place accuracy when multiplying by π , use the following approximation:

Example: Find the length of the equator. The earth's diameter is 7926.68 miles.

$$\pi = 3 + \frac{1}{7} - \frac{1}{800} - \frac{1}{70,000} \quad (1)$$

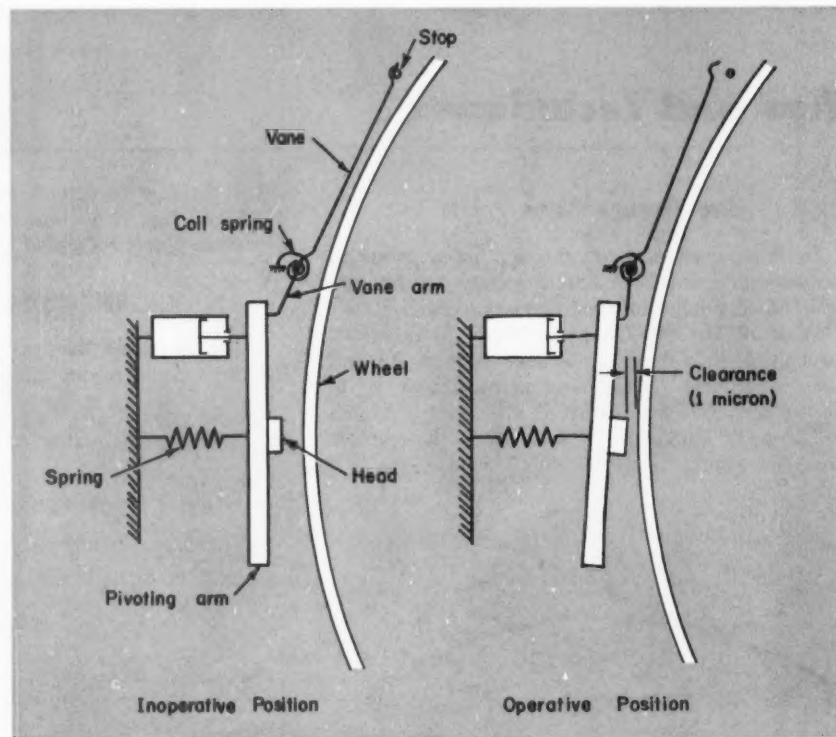
SOLUTION: 7926.68	\times	3	= 23,780.04
	\div	7	= 1,132.38
	\div	800	= 9.90
	\div	70,000	= 0.11

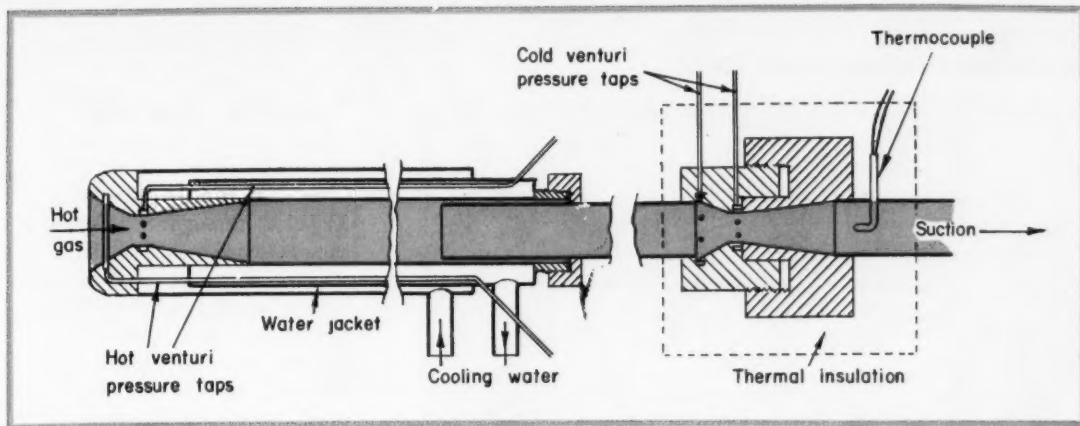
Performing the addition and subtraction indicated in Equation 1 gives the solution, 24,902.41 miles.—DIETER K. SCHMIDT, San Jose, Calif.

scanning the field for *ideas*

Air film controls clearance between a recording head and wheel. Air, dragged around by the wheel, supports the pivoted head against spring loading. To prevent the head from touching when the wheel stops, a spring-loaded vane holds the head away

from the wheel. When the wheel is turning, air drag forces the vane away from the wheel to release the pivoted head. Air-film support principle employed in a data recorder developed by NV Philips' Gloeilampen-fabrieken, Eindhoven, Holland.



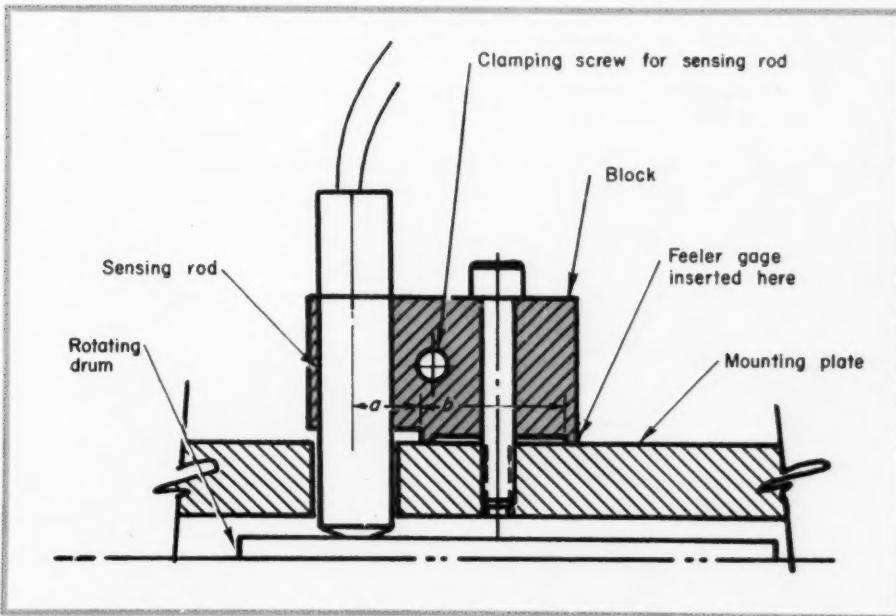


Pneumatic pyrometer gages gas temperature by measuring change in gas density. A continuous sample of hot gas is cooled by a water jacket. Temperature of the hot gas is proportional to that of the cooled gas multiplied by the ratio of

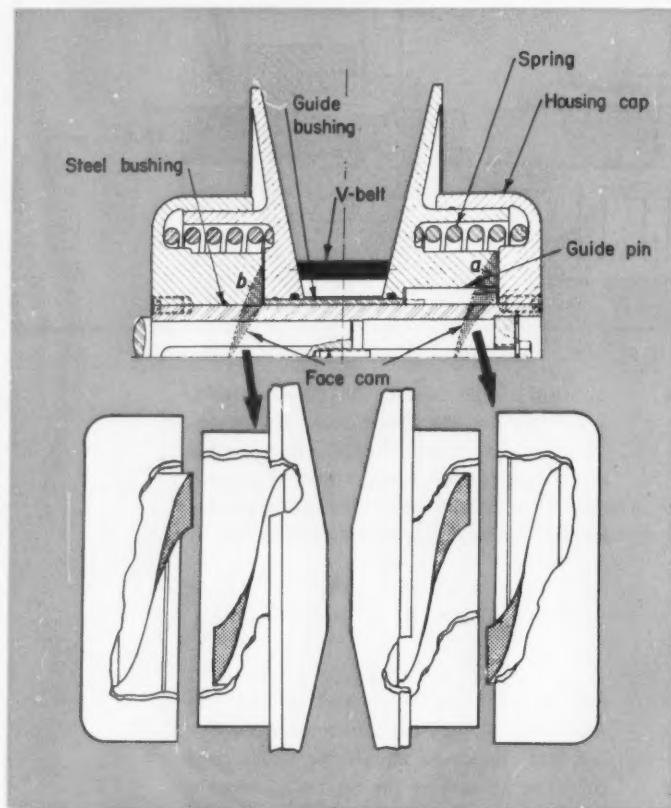
pressure drops across the two venturis. Thus, the hot gas temperature can be determined by thermocouple measurement of the cooled gas temperature. Principle employed in pyrometer developed by Atlantic Pyrometers Inc., Hawthorne, N. J.

Shimless "shimming" positions pivoted block to obtain high adjustment accuracy. To provide a specified clearance between the sensing rod and the rotating drum, a feeler gage is inserted between the outer end of the bar and the mounting plate. The sensing rod is placed against the drum, and clamped to the pivoted bar. Then the gage is removed and the bar piv-

oted so that the outer end touches the mounting plate. Clearance between the rod and the drum equals the feeler gage thickness divided by the ratio of dimension b to a . Lever ratio principle for increased measuring accuracy employed in a magnetic drum system developed by Magne-Head Div. of General Instrument Corp., Hawthorne, Calif.



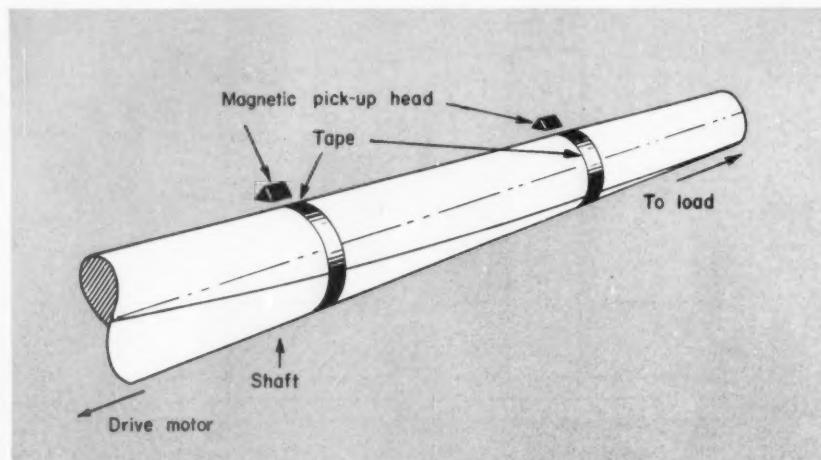
SCANNING THE FIELD FOR IDEAS



Face-cam regulator

adjusts V-belt squeeze in proportion to belt tension. The split cone sheave is driven through housing caps attached to the shaft. A cam follower is provided on the outer end of each half of the sheave. Matching face cams are included on each of the housing caps. Thus, any change in belt tension causes relative motion of the sheave and caps. The lateral component of this motion adjusts the squeeze on the belt. Principle employed in a sheave by Heinrich Desch GmbH, Neheim - Hueston, Germany.

Paired tape pulses measure shaft speed, torque, and power. A reference frequency is recorded directly on the tapes while the shaft is rotating at no load. This magnetization induces voltages in the pick-up heads. The phase relationship of the voltages measures the angular twist (or torque) under load, while the frequency of the voltages measures shaft speed. The two values are combined to indicate power transmitted. Principle employed in a power meter developed by Sierra Research Corp., Buffalo, N. Y.



*For maximum torque
capacity at minimum
weight...*

The Prestressed Shaft

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As a torsion member, the conventional solid shaft is relatively inefficient. Outer fiber strength limits the torque capacity while inner fibers are not nearly stressed to the same limit.

Shafts made up of prestressed concentric tubes provide an effective means of approaching ideal conditions of stress distribution. Basic concepts and advantages of this shaft design are outlined in this article.

A SHAFT made up of a series of prestressed concentric tubes can resist up to 33 per cent more torque than a solid shaft of the same outside diameter and material. Moreover, a prestressed shaft with the same torque capacity and OD as a solid shaft can be designed to weigh up to 40 per cent less than the solid shaft.

In a conventional shaft, shear stress varies linearly from a maximum at the outer fibers to zero at the shaft center. In a prestressed concentric-tube

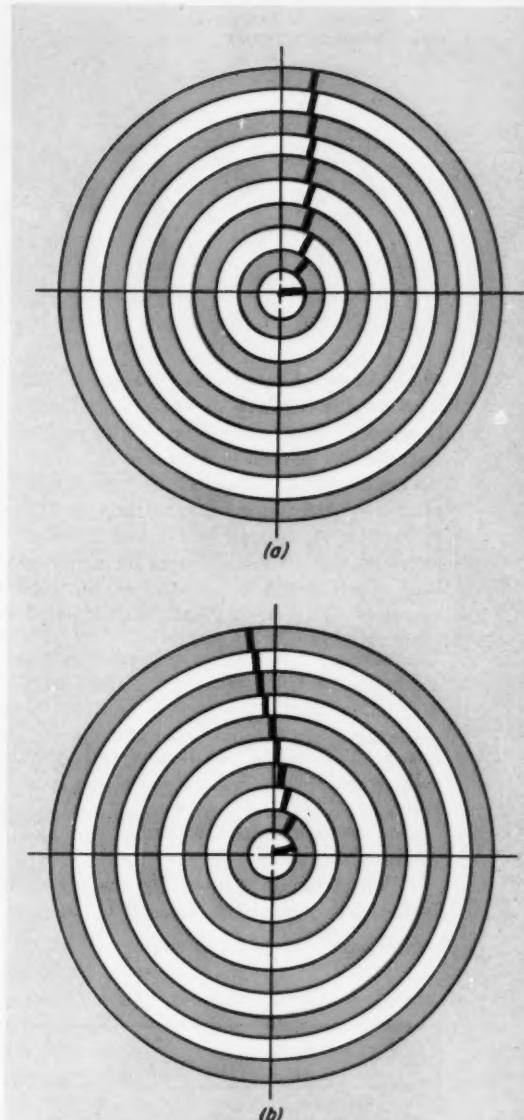
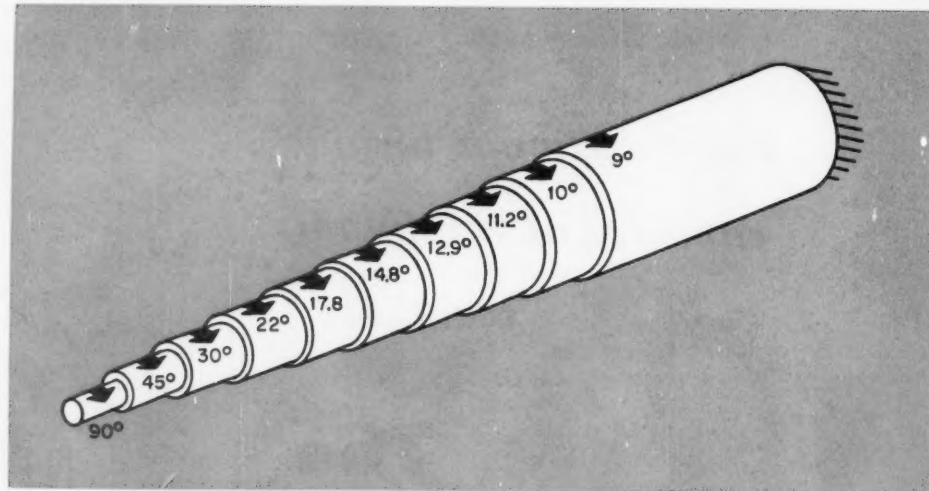


Fig. 1 — Prestressed concentric-tube shaft showing, *a*, shaft components with prestress torque applied and, *b*, shaft components in prestressed condition after torque is released.

THE PRESTRESSED SHAFT

Fig. 2 — Concentric-tube shaft discussed in example, showing prestress angles θ .



shaft, however, stress distribution approaches the ideal condition where all fibers in the shaft are equally stressed. Thus, nearly the full strength of the shaft material can be used to resist torque.

Prestressing of a concentric-tube shaft is accomplished by twisting each tube through a given angle, θ , Fig. 1a, so that all sections of the shaft are subjected to the same maximum shear stress at design load. Thus, angle θ increases as the tube diameter decreases. This angle may be calculated from the basic relationship

$$\theta = 57.3 \frac{S_s L}{G c} \quad (1)$$

For a shaft of a given length and material, either solid or hollow, $\theta c \propto S_s$. If the stress, S_s , is held constant, $\theta c = K$.

The concentric-tube assembly can be prestressed by using this procedure:

I. The concentric tubes are assembled, and rigidly fastened together at one end by welding or some

other suitable method.

2. While this end of the shaft is held stationary, each tube is twisted through the calculated angle θ , Fig. 1a.

3. While the shaft components are held in the fully stressed position, they are fastened by some suitable method, such as welding or pinning, so that they maintain their relative positions.

4. The applied torque is released. The shaft components then assume their prestressed condition, Fig. 1b, with the outer fibers stressed in one direction and the inner fibers stressed in the opposite direction.

EXAMPLE: Assume a shaft is made up of nine concentric tubes of equal wall thickness, and a central rod. What is θ for each shaft component? Material is steel. The shaft is 15 ft long, and has a 10-in. OD. Wall thickness of the tubes is 0.5 in., and the central rod has a one-in. OD. Assume $S_s = 100,000$ psi, and $G = 11.5 \times 10^6$.

Calculating θ by means of Equation 1 yields the values listed in Table 1. Fig. 2 illustrates how this shaft is prestressed. When full design torque is applied to the shaft in service, the components will return to the maximum stress position, Fig. 1a.

Basic Relationships: In a solid shaft, shear stress is zero at the axis and increases in direct proportion to the distance from the axis. In Fig. 3, stress at incremental area, dA , is $(v/c) S_s$, where S_s is the outer fiber stress. Force exerted by this stress is $v/c S_s dA$. Moment of this force about the shaft axis is $(v^2/c) S_s dA$. By summation of moments,

$$T_1 = \int_0^c \frac{v^2}{c} S_s dA = \frac{S_s}{c} \int_0^c v^2 dA = \frac{S_s}{c} J$$

For a solid shaft, J is $(\pi/2) c^4$. Thus,

$$T_1 = \frac{\pi S_s}{2c} c^4 = \frac{\pi S_s}{2} c^3$$

If all of the shaft fibers are uniformly stressed, as in an ideal concentric-tube shaft, the incremental

Nomenclature

c	Distance from geometric axis to outer fiber, in.
c_i	Inside radius of shaft, in.
D	Outside diameter of shaft, in.
d	Rod diameter, in.
G	Modulus of rigidity, psi
J	Polar moment of inertia, in. ⁴
L	Length of shaft, in.
r	Outside radius of shaft, in.
S_s	Maximum shear stress, psi
T_1	Resisting torque in a solid shaft, lb-in.
T_2	Resisting torque in a concentric-tube shaft, lb-in.
v	Distance from shaft center to incremental area dA , in.
θ	Angle of twist, deg

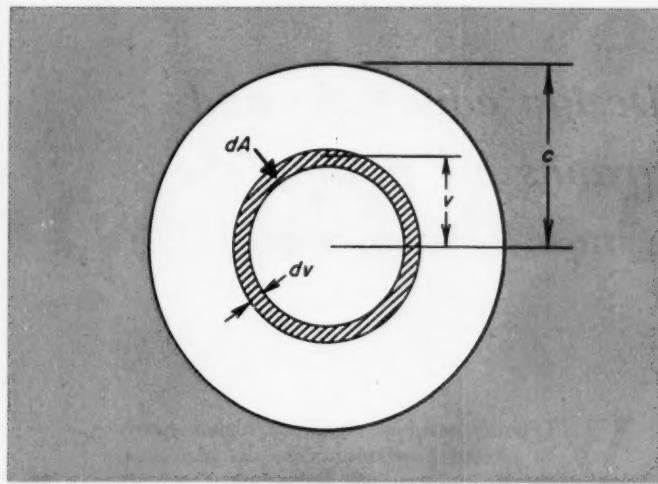
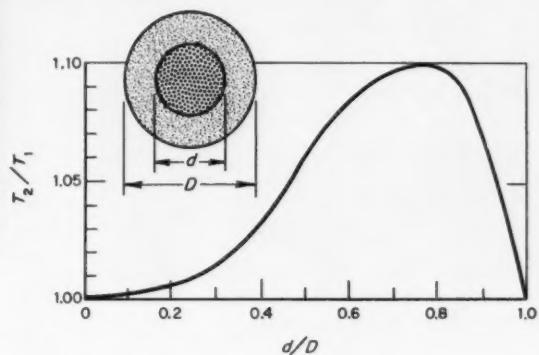


Fig. 3—Incremental area and dimensions for analysis of the torque-carrying capacity of a solid shaft.

Fig. 4—Ratio of T_2/T_1 as a function of d/D for a prestressed shaft made up of a sleeve and a central rod. Maximum gain in torque capacity is obtained when the ID is 80 per cent of the OD.



force becomes $S_s dA$. Moment of this force about the shaft axis is $v S_s dA$.

The sum of the moments is:

$$T_2 = S_s \int_0^c v dA$$

Thus, for a uniformly stressed shaft, resisting torque T_2 is

$$T_2 = \frac{2\pi}{3} S_s c^3$$

For the two shafts, ratio of the resisting torques is

$$\frac{T_2}{T_1} = \frac{(2\pi/3) S_s c^3}{(\pi/2) S_s c^3} = 1.333$$

Since this 33 per cent increase in torque resistance is based on an ideal stress distribution, it would be possible only if the shaft were made from an infinite number of concentric tubes. For the example shaft design, which uses nine tubes and a central rod, the gain in torque capacity is somewhat less than 33 per cent. This gain may be readily calculated by summing the torques resisted by each component.

$$\begin{aligned} T_2 &= \frac{S_s}{c_1} J_1 + \frac{S_s}{c_2} J_2 + \dots + \frac{S_s}{c_{10}} J_{10} \\ &= \frac{\pi}{2} S_s \left(\frac{r_1^4 - r_2^4}{r_1} + \frac{r_2^4 - r_3^4}{r_2} + \dots + \right. \\ &\quad \left. \frac{r_9^4 - r_{10}^4}{r_9} + r_{10}^3 \right) \end{aligned}$$

From this summation, $T_2/T_1 = 2.433/1.960 = 1.24$, a 24 per cent increase in torque capacity.

If a shaft is made up of a central rod and a single sleeve, the increase in torque capacity is a function of the ratio of rod diameter d to sleeve diameter D , Fig. 4. Maximum gain in torque capacity—about 10 per cent—is obtained when $d/D = 0.8$.

One limitation of prestressed shafts should be kept in mind. The capacity of such shafts is reduced

if torque is applied in a direction opposite to that in which the components were originally twisted for prestressing.

Advantages: Weight savings of approximately 40 per cent are theoretically possible when a prestressed concentric-tube shaft is substituted for a solid shaft of the same OD and torque capacity. Again, this is an ideal situation possible only if the prestressed shaft were made up of an infinite number of tubes.

For a solid shaft and a prestressed concentric-tube shaft of the same OD and torque capacity, $T_2 = T_1$. Then,

$$\frac{\pi}{2} S_s c^3 = \frac{2\pi}{3} S_s (c^3 - c_i^3)$$

and $c_i = 0.63 c$. Corresponding weight saving is approximately 40 per cent.

For the shaft design detailed in Table 1, the four outer tubes (ID = 6 in.) are capable of carrying 98 per cent of the torque resisted by a solid shaft of the same diameter and material.

Table 1—Prestress Angles

D (in.)	θ (deg)	D (in.)	θ (deg)
10	9	5	17.8
9	10	4	22
8	11.2	3	30
7	12.9	2	45
6	14.8	1	90

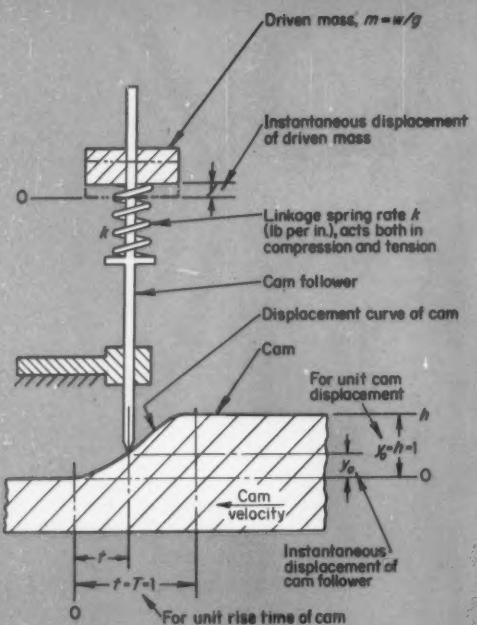


Fig. 1—The basic cam configuration with nomenclature.

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Design equations and graphs for finding the dynamic response of . . .

WITH increased emphasis on higher speeds in present mechanisms, the designer must think in terms of lightweight elements which have a high strength-to-weight ratio.

Also to be considered are the vibrational characteristics of the mechanism. At low speeds, damping and friction usually keep disturbances arising from induced vibrations to a negligible value. How-

For high-speed or highly elastic cam systems, so-called cycloidal motion is the growing favorite among the common motion curves. Although it imparts a higher acceleration to the follower, dynamic response of the driven mass is generally less severe.

However, predicting the specific vibration characteristics of a design is no easy task. Here, all worked out, are equations and graphs for the response of dwell-rise-dwell systems driven by cycloidal-motion cams.

What happens during the planned rise time can be determined quickly—and oscillations remaining after the rise can also be found.

Cycloidal-Motion Cam Systems

ever, as speed is increased, induced vibrations become more noticeable and in many cases affect proper cyclic operation. Also, internal stresses may cause rupture of the mechanism.

Cycloidal motion has gained wide acceptance as one input motion that yields relatively low vibrational effects in high-speed mechanisms.

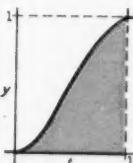
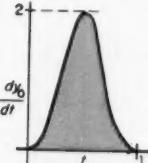
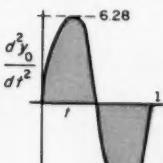
This article presents an analytical method of deter-

mining quantitative values of the vibrational effects of cam and follower systems which are of the dwell-rise-dwell type and have a cycloidal-motion input.

The Basic Configuration

Most cam and follower systems can be expressed in the manner shown in Fig. 1.

Table 1—Equations for Cycloidal-Motion Cam Input and Driven-Mass Output

Cam Input	Driven-Mass Output	
	During Rise ($0 \leq t \leq 1$)	After Rise ($t_1 \geq 1$)
	Displacement $y = t + \frac{r^2}{2\pi(1-r^2)} (\sin 2\pi t - \frac{1}{r^3} \sin 2\pi r t)$ $y_0 = t - \frac{1}{2\pi} \sin 2\pi r t$	$y = 1 - \frac{\sqrt{1-\cos 2\pi r}}{\sqrt{2\pi r(r^2-1)}} \times \cos(2\pi r t_1 + \pi r)$
	Velocity $\frac{dy}{dt} = 1 + \frac{r^2}{1-r^2} \left(\cos 2\pi t - \frac{1}{r^2} \cos 2\pi r t \right)$ $\frac{dy_0}{dt} = 1 - \cos 2\pi r t$	$\frac{dy}{dt_1} = \frac{\sqrt{2(1-\cos 2\pi r)}}{r^2-1} \times \sin(2\pi r t_1 + \pi r)$
	Acceleration $\frac{d^2y}{dt^2} = 2\pi \frac{r^2}{r^2-1} \left(\sin 2\pi t - \frac{1}{r} \sin 2\pi r t \right)$ $\frac{d^2y_0}{dt^2} = 2\pi \sin 2\pi r t$	$\frac{d^2y}{dt_1^2} = \frac{2\sqrt{2\pi r}\sqrt{1-\cos 2\pi r}}{r^2-1} \times \cos(2\pi r t_1 + \pi r)$

Newton's second law states that, if an unbalanced force acts upon a body, the body will be accelerated, or

$$F = ma \quad (1)$$

Substituting the parameters from Fig. 1 into Equation 1 leads to

$$(y_0 - y)k = \left(\frac{w}{g} \right) \frac{d^2y}{dt^2} \quad (2)$$

Finally,

$$y_0 = \left(\frac{w}{kg} \right) \frac{d^2y}{dt^2} + y \quad (3)$$

Equation 3 holds at all times. But with a high linkage spring rate k present in the system, Equation 3 reduces to $y = y_0$ for all practical purposes. The instantaneous displacement path of the driven mass then reproduces that of the cam follower.

In highly elastic systems, however, this happy simplification is not realistic. For example, in a high-speed, remote-control device, where some distant body is under mechanical control of a master actuating mechanism via a long steel tape or wire system, the output does not faithfully reproduce the input displacement path due to the springiness of the connecting member. Predicting the behavior of such a system requires that an expression be derived for the output in terms of the input. Equation 3 must be solved for y in terms of y_0 .

The Laplace transform presents a convenient method for solving this problem. Details of the method are not included here but the results are applied to the cycloidal-motion profile.

The Cycloidal-Motion Curve

Cycloidal motion is one of the more frequently used motions utilized for cam followers today in high-speed mechanisms. It is gaining favor over the constant-acceleration and simple-harmonic curves which are satisfactory over the lower-speed spectrum. But in the upper register, due to their instant application of acceleration, they are to be avoided.

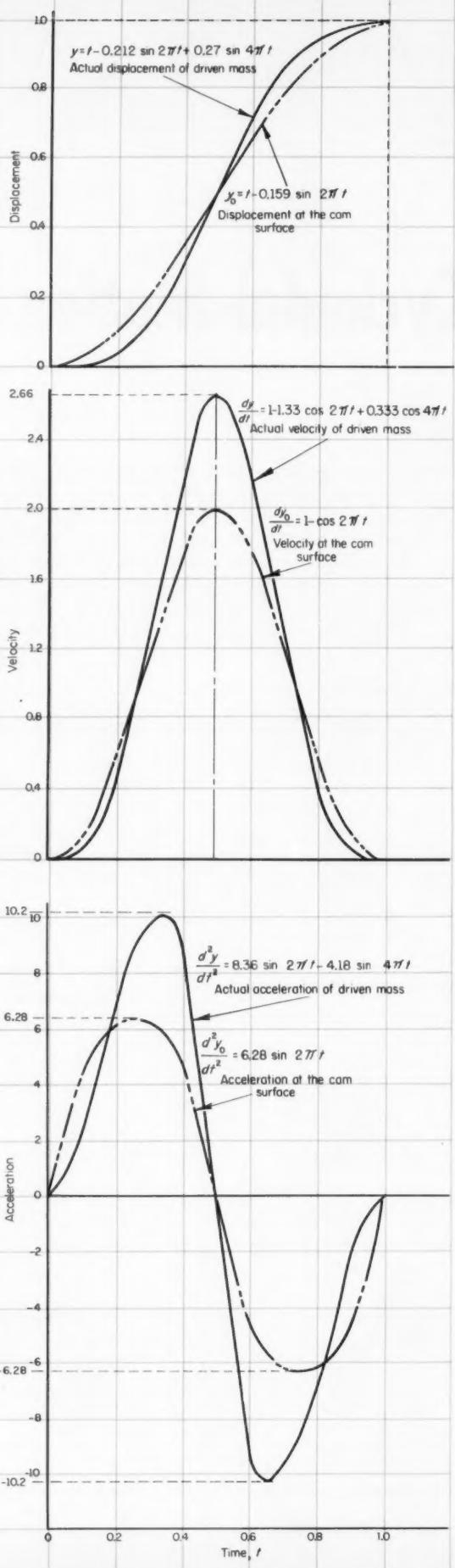
The general displacement equation for cycloidal-motion input is

$$y_0 = \frac{h}{2\pi} \left(\frac{2\pi}{T} t - \sin \frac{2\pi}{T} t \right) \quad (4)$$

Output Motion during Rise

Applying the Laplace-transform method to Equations 3 and 4 leads to the following equation for

Fig. 2—Actual motion characteristics of the driven mass for $r=2$, compared with the follower displacement at the cam surface during the cam-rise time. Parameter r is the ratio of cam-rise time to the period of natural vibration of the system.



output displacement, the displacement of the driven mass:

$$y = h \left[\frac{t}{T} + \frac{r^2}{2\pi(1-r^2)} \left(\sin \frac{2\pi}{T} t - \frac{1}{r^3} \sin \frac{2\pi}{T} rt \right) \right] \quad (5)$$

where r = ratio of cam-rise time T to natural-vibration period P_n of the system.

Symbolically,

$$r = \frac{T}{P_n} \quad (6)$$

where

$$P_n = \frac{2\pi}{\sqrt{\frac{kg}{w}}} \quad (7)$$

For convenience, Equation 5 is restated in terms of

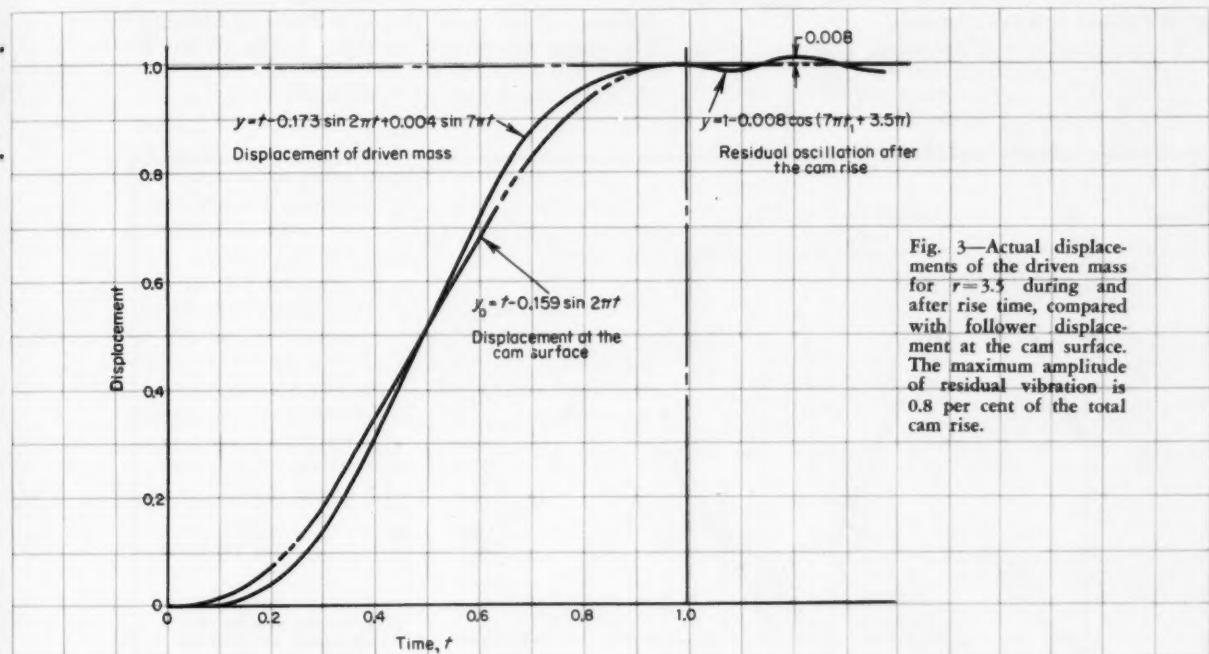


Fig. 3—Actual displacements of the driven mass for $r=3.5$ during and after rise time, compared with follower displacement at the cam surface. The maximum amplitude of residual vibration is 0.8 per cent of the total cam rise.

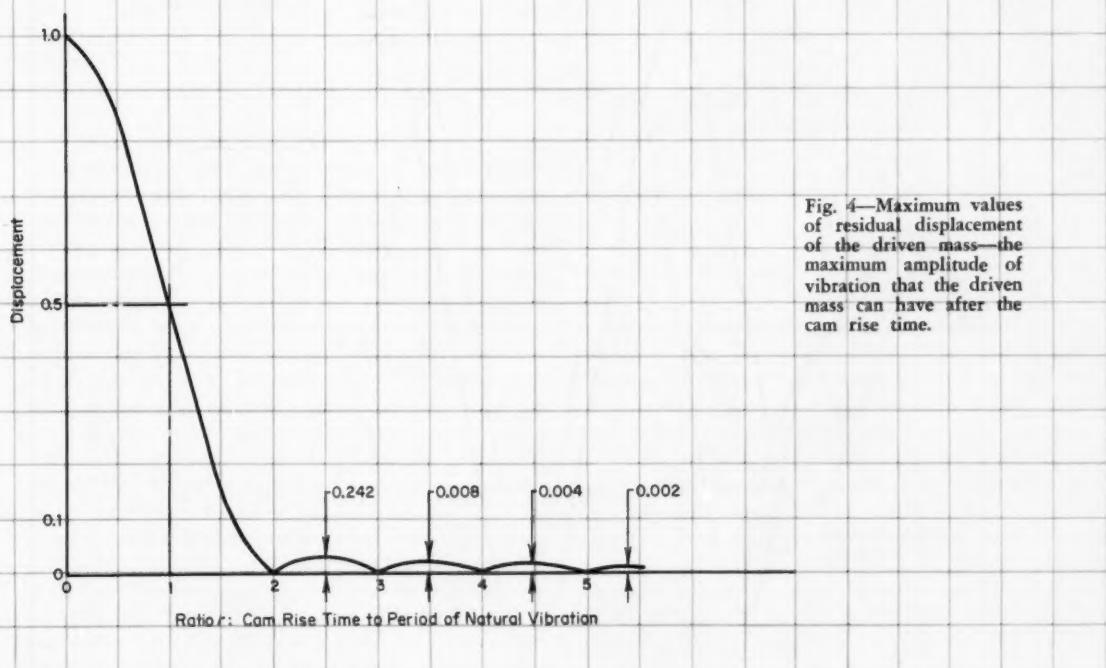


Fig. 4—Maximum values of residual displacement of the driven mass—the maximum amplitude of vibration that the driven mass can have after the cam rise time.

unit displacement ($h = 1$) and unit rise time ($T = 1$) of the cam. The instantaneous displacement of the driven mass during the cam rise time, and the instantaneous velocity and acceleration, are stated as equations in the center column of Table 1. The left-hand column in Table 1 presents the comparable cycloidal-motion cam input equations.

Close examination of the equations for output during rise reveals that for high values of r the instantaneous displacement of the driven mass is essentially the same as the instantaneous displacement of the follower at the cam surface.

As the value of r is decreased, a definite trend

develops and becomes more pronounced as r approaches unity. During the cam rise, the displacement of the driven mass lags, catches up, and then overshoots the corresponding follower displacement at the cam surface.

Obviously, the greater the departure of the output displacement path from the input, the greater the departures of velocity and acceleration. These variations are minimized when r is high; that is, when the ratio of rise time T to period of natural vibration P_n is high. For r to have a high value: 1. The cam rise time should be as long as possible. 2. The linkage spring rate should be high. 3. The weight of

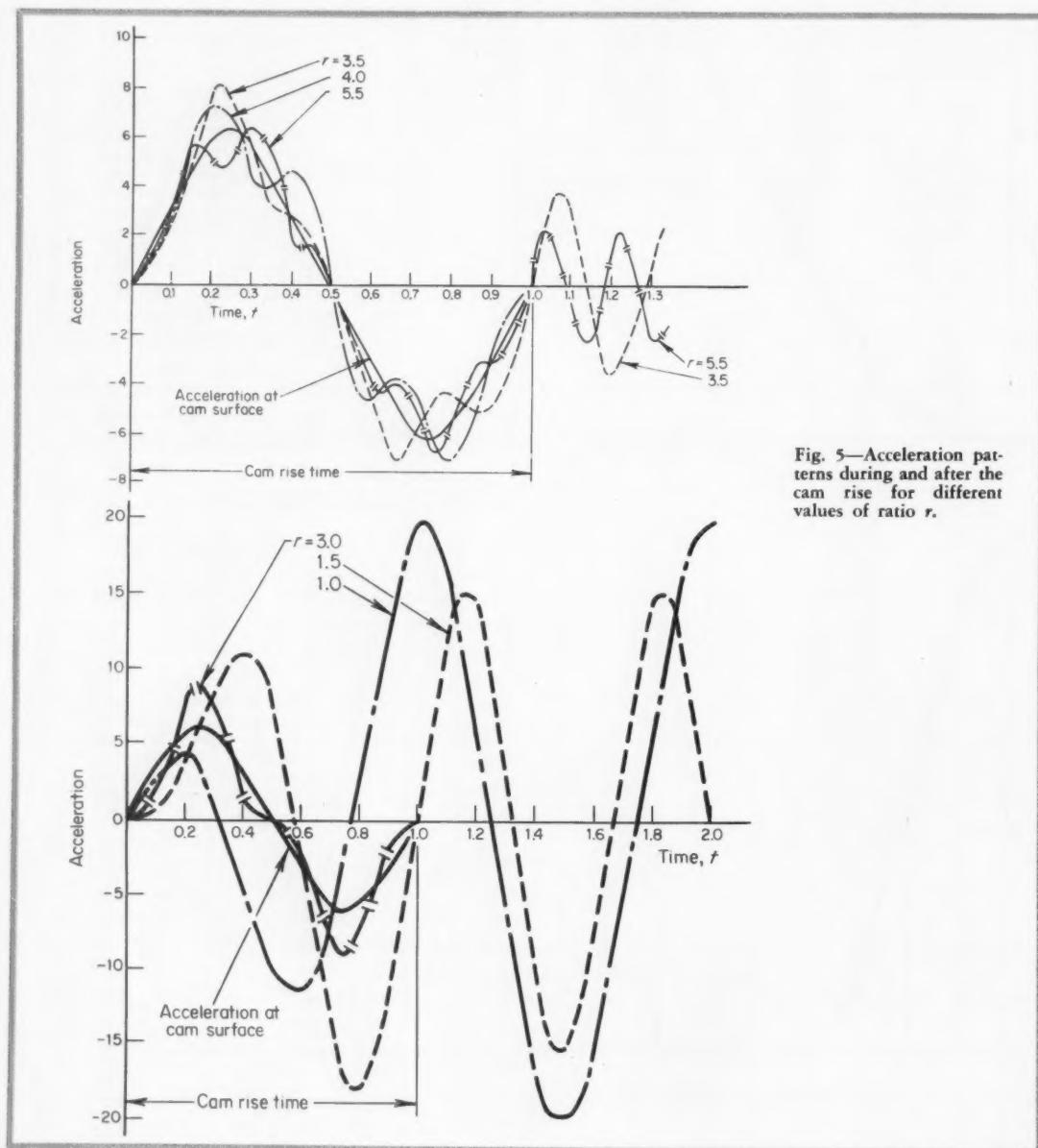


Fig. 5—Acceleration patterns during and after the cam rise for different values of ratio r .

the driven mass should be low.

Fig. 2 shows output curves of the driven mass for $r = 2$, a rather low value, incidentally, for a system to have.

Residual Effects after Rise

The example in Fig. 2 shows the effects produced in the output functions when $r = 2$. In particular, it demonstrates the lack of conformity between output and input during the cam rise time for low values of r . If the speed of the machine were increased still further, the cam rise time would approach the natural period of vibration of the cam follower system, leading to increased internal stresses within parts of the machine.

Furthermore, these output departures from the input are not limited to the period of cam rise exclusively. Residual stresses can exist after the rise time is completed. They result in forces which oscillate the driven mass about its final resting point. These oscillations last until damped out, usually by friction or by some aligning device.

To determine the mathematical expressions for displacement, velocity, and acceleration of the driven mass after the cam rise, the Laplace-transform procedure is again applied.

The general displacement equation which results for the output of the driven mass is

$$y = 1 - \frac{T}{2\pi r} \left\{ \left[\frac{\sin 2\pi r}{T(r^2 - 1)} \right]^2 + \left[\frac{1}{1-r^2} - \frac{\cos 2\pi r}{1-r^2} \right]^2 \right\}^{\frac{1}{2}} \times \cos \left(\frac{2\pi r}{T} t_1 + \psi \right) \quad (8)$$

where

$$\psi = \tan^{-1} (T \tan \pi r)$$

Again, equations of displacement, velocity, and acceleration for unit displacement and unit rise time are presented in Table 1. Inspection of the equations, right-hand column of Table 1, shows that for high values of r the residual displacement, velocity, and acceleration effects are almost negligible. However, as the value of r is lowered, approaching unity, the system will have increased vibrational tendencies.

Insertion of $r = 2$ in the "after-rise" equations of Table 1 reveals that there will be no residual vibrations for this particular value. Indeed, there are no residual effects when r is any integer (except unity); the effects are noticeable mainly at the half points between integers.

In high-speed, remote-control devices, where some distant mass is under mechanical control of a master actuating mechanism via long steel tapes or equivalent members having a low spring rate, the designer is primarily interested in the tape stresses during and after the cam rise time and in the residual displacements of the driven mass after the cam rise time.

In many instances, aligning mechanisms are used to register the position of the driven mass accurately after the cam rise. Knowing the residual displacement characteristics permits the designer to allow for this displacement variation in design of the aligner.

Fig. 3 to 6 give an insight to the quantitative values of displacements and stresses (resulting from inertia or acceleration forces) that occur during the cam rise time, and after, for different values of parameter r .

Conclusions

The ratio of cam-rise time to period of natural vibration is a useful parameter in predicting the be-

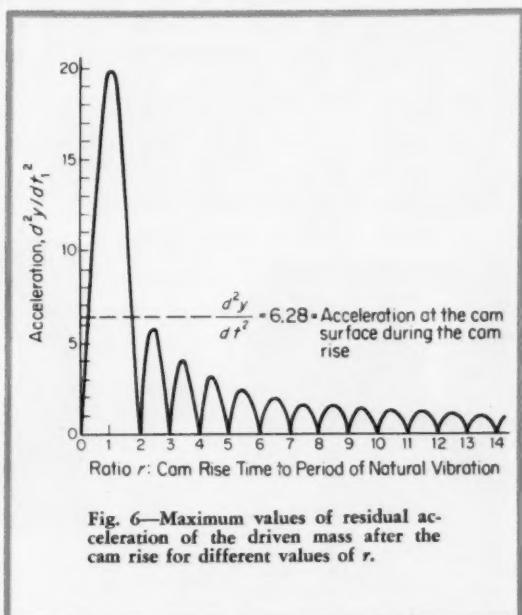


Fig. 6—Maximum values of residual acceleration of the driven mass after the cam rise for different values of r .

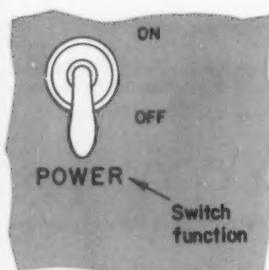
havior of a "springy" system. High values of this ratio, r , indicate a faithful reproduction of the path of the driven mass with that of the follower displacement at the cam surface, with corresponding agreements in velocity and acceleration. Low values of this ratio point to vibrational problems, higher velocities, and increased dynamic loads.

For cams with a cycloidal profile of the dwell-rise-dwell type, residual vibrations cease when the value of r is any integer except unity. This phenomenon may be used to advantage. For instance, if the system had an r of 3.2, it might be desirable to increase the weight of the driven mass to effect an r of 3.0, thereby eliminating residual vibrations though increasing the dynamic loads during the cam-rise time slightly.

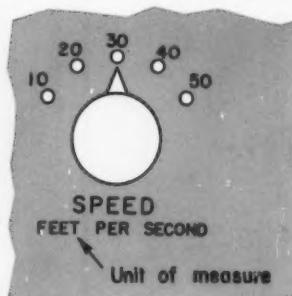
10 Tips on Control Panel Designations

FRANK WILLIAM WOOD JR., Standards Engineer, Vitro Laboratories, Silver Spring, Md.

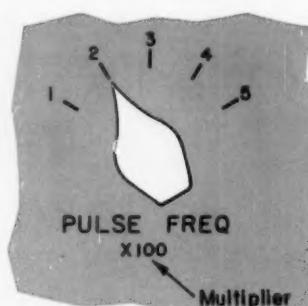
Turning the right knobs, the right amount, at the right time, are critical functions of equipment operators stationed at control panels. Whether settings are made quickly or slowly, they must be equally accurate. Here are considerations which help to make panel manipulations accurate.



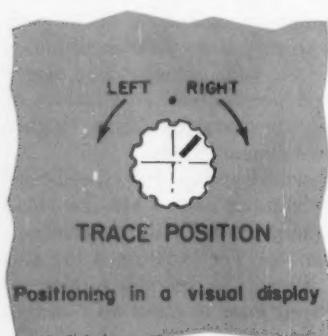
Indicate functions of controls. Don't make control operators guess. If a switch controls power, for example, POWER should be on the panel.



Designate units of measure. Scale multipliers may be needed for complete readings.



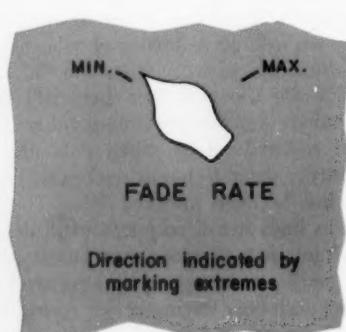
Multiplier



Positioning in a visual display

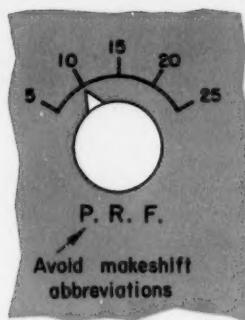


Direction indicated by arrow and word



Direction indicated by marking extremes

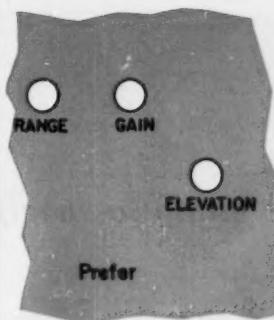
Indicate directions to move controls. Both arrows and words may be necessary.



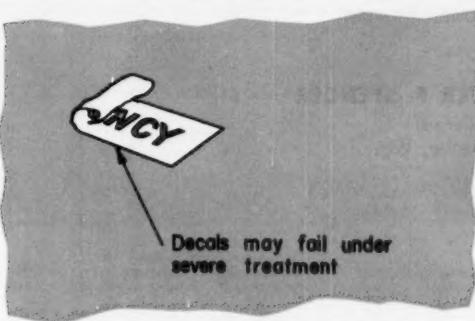
Typical Abbreviations
From MIL-STD-103

Antenna ANT.
Azimuth AZ
Clockwise CW
Elevation EL
Frequency FREQ

Limit the use of abbreviations. In control designations, abbreviations save space, but they can increase confusion and operator error. When necessary, use abbreviations from MIL-STD-103.



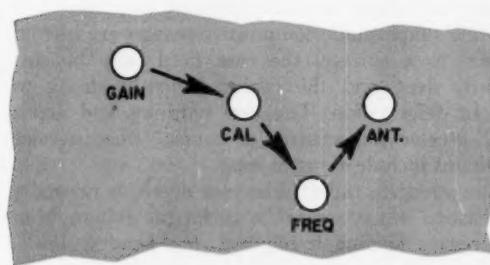
Be consistent in locating designations.



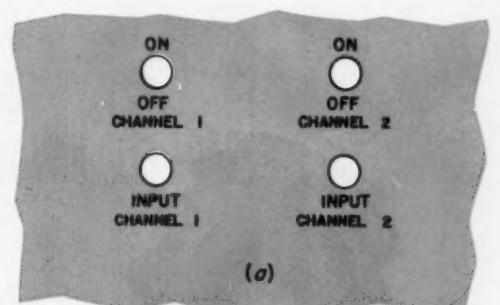
Make markings durable. Marking method depends on the service environment.



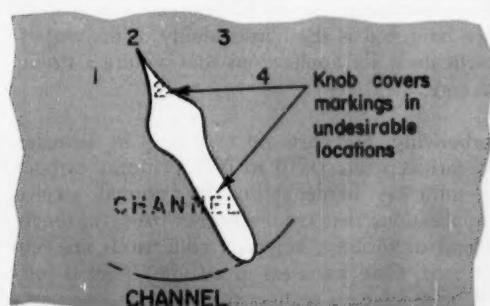
Make markings legible. Operator must read clearly in his normal operating position. Use large characters for groups of controls.



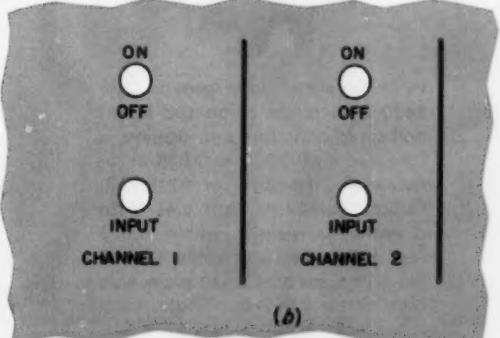
Indicate sequence for operation of controls, if sequence is necessary. Don't depend on an operator's memory, and don't require him to page through a bulky instruction manual.



(a)



Make markings visible. Locate designations so that they will not be covered by control knobs and pointers.



(b)

Avoid ambiguity. Indicate group at each control, *a*, or use separating lines, *b*.

A basic guide to specifying

Surface Hardening of Steels

Part 2—Material Selection

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Hydraulic-pump drive gear of SAE 8620 steel is gas carburized in endothermic atmosphere to achieve a case depth of 0.020 to 0.025 in. at Rockwell C hardness of 61 to 63. Critical dimensions held are: Pitch diameter, concentric within 0.003 in.; bore, accurate within 0.0015 in.; sides, parallel and square with bore within 0.002 in. Photo, courtesy Ipsen Industries Inc.

A SURFACE-HARDENED material has a composite structure. Properties required of both the case and the core must be considered for proper material specification. This article, which concludes the series, relates material-selection factors to the various surface-hardening methods.

When simple static compressive stresses are exerted normal to a surface, the case need only be sufficiently deep and the core sufficiently strong to prevent deformation. The case hardness and depth is of greater importance, of course, when service conditions include abrasive wear.

Core strength, rather than case depth, is normally emphasized when resistance to fatigue failure from compressive loading is required. For bending loads, core strength and case depth are considered equally important.

Selection

The prime factor in the selection of a steel to be surface hardened is the hardenability of the material, particularly for applications that require a strong, tough core.

Carburizing: For parts up to 0.5 in. in diameter, plain carbon steels (0.10 to 0.25 per cent carbon) have sufficient hardenability for normal service. For applications that require higher strength, toughness, and uniformity, however, alloy steels are generally used. Core hardness in an alloy steel is relatively insensitive to section thickness, as compared to that in a carbon steel, Fig. 1.¹ In general, an

*Now with Lewis Research Center, NASA, Cleveland, Ohio.
¹References are tabulated at end of article.

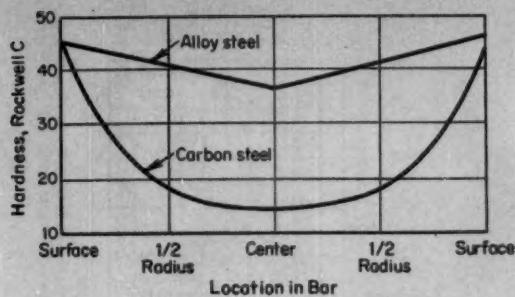


Fig. 1—Hardenability traverse curves of two carburizing steels showing significant differences in core properties of 1-in. diam carbon and alloy (Cr-Ni-Mo) bars. Specimens were water quenched directly from carburizing temperature.

Fig. 2—Jominy end-quench hardenability curves for various carburizing steels.

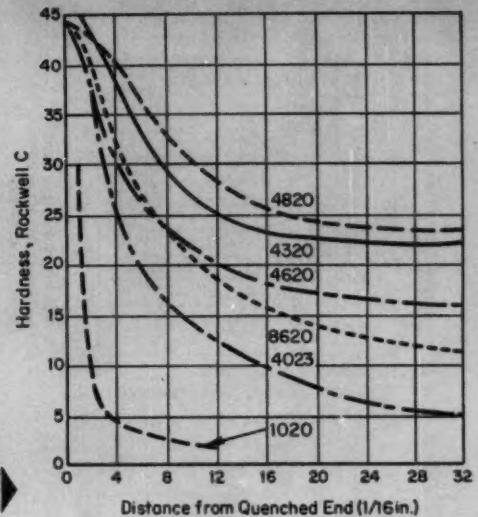


Table 1—Average Core Properties of Steels After Various Carburizing Cycles

AISI Type*	Heat Treatment		Bar Diam (in.)	Tensile Strength (1000 psi)	Yield Strength (1000 psi)	Elongation (per cent)	Area Reduction (per cent)	Impact, Izod (ft-lb)	Hardness (Bhn)
	Quench Temperature† (F)	Tempering Temperature (F)							
C1015 ^a	1425 (water)	350	0.5	106	60	15.0	32.9	50.0	217
		350	1.0	76	44	30.0	69.0	85.0	156
		350	2.0	71	41	32.0	70.4	94.0	131
		350	4.0	67	39	30.5	69.5	96.3	121
C1022 ^a	1425 (water)	350	0.5	135	67	13.6	24.3	14.3	262
		350	1.0	87	56	25.5	57.3	70.3	179
		350	2.0	82	50	30.0	69.6	105.5	163
		350	4.0	74	40	32.5	71.6	97.8	149
C1118 ^a	1450 (water)	350	0.5	145	90	13.2	30.8	15.3	285
		350	1.0	103	59	19.0	45.9	33.5	207
		350	2.0	82	48	27.3	65.5	36.7	167
		350	4.0	75	43	31.0	67.4	59.8	149
2317 ^a	1700	300	1.0	145	115	15.0	50.0	...	302
	1425	300	1.0	130	100	18.0	50.0	...	277
	1475	300	1.0	138	109	18.5	52.0	...	285
	1525	300	1.0	140	112	20.0	54.0	...	293
3120 ^a	1700	300	1.0	147	121	14.5	51.0	...	311
	1425	300	1.0	133	105	15.5	52.0	...	277
	1475	300	1.0	134	108	16.0	54.0	...	285
	1525	300	1.0	144	116	17.0	55.0	...	302
4320 ^a	1700	300	1.0	180	160	13.0	52.0	40.0	...
	1425	300	1.0	155	125	12.0	24.0	28.0	...
	1475	300	1.0	180	160	13.0	45.0	42.0	...
	1525	300	1.0	185	160	13.0	52.0	50.0	...
4620 ^a	1425	300	1.0	130	90	17.0	45.0	25.0	...
	1475	300	1.0	130	95	18.0	52.0	42.0	...
	1525	300	1.0	135	105	19.0	55.0	52.0	...
	1700	300	0.5	205	166	13.0	53.0	33.0	415
4820 ^a	1475	300	0.5	208	167	14.0	52.0	44.0	415
	1500, 1450	300	0.5	204	166	14.0	53.0	31.0	415
	1700	450	0.5	200	170	13.0	53.0	30.0	401
	1475	450	0.5	205	184	13.0	53.0	47.0	415
8620 ^a	1500, 1450	450	0.5	196	172	13.0	53.0	29.0	401
	1700	300	0.5	173	142	14.0	46.0	53.0	375
	1525	300	0.5	146	123	15.0	45.0	55.0	321
	1550	300	0.5	144	116	15.0	49.0	57.0	311
9310 ^a	1700	300	1.0	146	114	16.0	47.0	50.0	321
	1525	300	1.0	137	103	16.0	50.0	53.0	302
	1550	300	1.0	133	102	18.0	53.0	60.0	293
	1475, 1425	300	0.5	180	144	15.0	59.0	57.0	375
9320 ^a	1420	300	1.0	180	155	12.0	45.0
	1470	300	1.0	210	180	12.0	45.0
	1520	300	1.0	220	185	12.0	45.0

*Superscripts are data source references, tabulated at end of article.

†All steels carburized at 1700 F for 8 hr. Quench from 1700 F represents direct quench from carburizing box or pot. Quenches from lower temperatures indicate a slow cool from 1700 F, then a reheat to the indicated temperature before the quench. Where two temperatures are shown, the cycle is a double quench and temper. All quenches are in oil unless otherwise indicated.

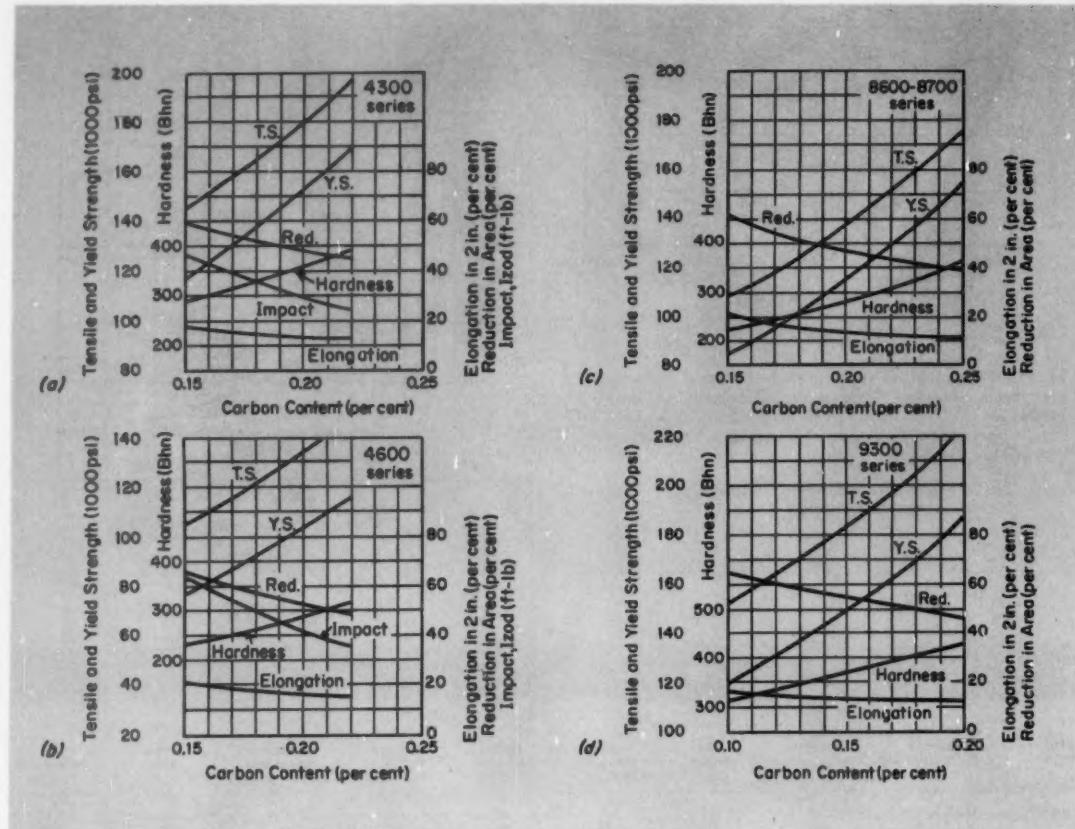


Fig. 3—Property-survey curves of *a*, 4300, *b*, 4600, *c*, 8600 and 8700, and *d*, 9300 steels showing effect of carbon content on core properties. Average values are given for 1-in. diam bars of medium to fine-grain steels, mock-carburized at 1650-1700 F, directly quenched in oil, and tempered at 300 F.

alloy steel that produces the desired core properties will have adequate case properties, including a Rockwell C hardness of about 60.

Data for determining core properties of carburizing steels are available in various forms, such as: 1. Jominy end-quench hardenability curves, Fig. 2,¹ for hardenability comparisons. 2. Properties surveys, Fig. 3,² for the effect of carbon content on various properties. 3. Tabular listings, Table 1, that show properties produced by various mock-carburizing cycles (actual temperatures used, but part is not actually carburized) on different section sizes.



Dimensional change is negligible on worm shaft after being liquid carburized to 0.024-in. case depth at Rockwell 30 N hardness of 76 to 80. Steel is SAE X-1315. Photo, courtesy Ajax Electric Co.

Induction Hardening: Materials normally used for induction-hardening applications, Table 2,⁷ also require adequate hardenability so that desired properties are obtained in both case and core. Medium carbon steels—above 0.30 per cent carbon—respond well to induction hardening; alloy steels that contain strong carbide formers such as chromium and molybdenum respond with difficulty. Alloys other than these are normally used for deep hardening.

Nitriding: A pretreatment is required for parts that are to be nitrided to: 1. Obtain the desired com-

Table 2—Cast Irons for Induction Hardening

Type	Treatment	Surface Hardness, Rockwell C	Remarks
Gray	1600-1700 F, water quench	45-55	Hardness increases with combined carbon content
Pearlitic malleable	1600-1700 F, water quench	48-58	Responds well
Meehanite	1550-1650 F, water quench	50-58	Types GA, GB, and GM particularly suitable
Ductile iron	1650-1700 F, water quench	55-58	Combined carbon content should be above 0.30 per cent

Table 3—Core Properties of Nitralloy Steels

Nitralloy Steel	Oil-Quench Temperature (F)	Tempering Temperature (F)	Tensile Strength (1000 psi)	Yield Strength (1000 psi)	Elongation (per cent)	Reduction in Area (per cent)	Hardness (Bhn)	Impact, Izod (ft-lb)
135	1750	1100	155	138	15	52	310	52
	1750	1200	138	120	20	58	280	65
	1750	1300	121	103	23	62	230	80
135 modified	1700	1100	206	182	13	46	415	...
	1700	1100	181	165	15	54	368	...
	1700	1200	159	141	17	56	320	...
	1700	1300	145	125	20	65	285	...
EZ	1700	1100	139	68*	16	44	293	...
	1700	1200	126	90*	17	45	255	...
	1800	1100	142	73*	14	41	293	...
	1800	1200	128	90*	18	46	262	...

*Proportional limit.

Table 4—Size Effect on Properties of Nitralloy 135

Tempering Temperature (F)	Tempering Time (hr)	Diam of Section (in.)	Tensile Strength (1000 psi)	Yield Strength (1000 psi)	Elongation (per cent)	Reduction in Area (per cent)	Hardness (Bhn)
1000	4	4	156	134	13	41	340
1100	4	4	133	113	17	48	302
1200	4	4	125	101	18	52	269
1000	3	3	159	141	13	40	340
1100	3	3	140	121	16	48	293
1200	3	3	127	105	18	56	255
1000	2	2	171	150	13	40	340
1100	2	2	158	138	16	51	302
1200	2	2	155	135	16	49	269
1000	1	1	182	165	13	44	351
1100	1	1	158	139	15	52	302
1200	1	1	139	121	20	59	269

Values above represent properties at $\frac{1}{2}$ radius.

bination of strength and ductility within the core which, of course, is not affected by subsequent nitriding. 2. Relieve any stresses that may have been produced by prior machining so that distortion and warping are minimized. 3. Condition the material so that the surface is receptive to nitrogen absorption. Pretreatment consists of heating the machined part to 1700 to 1800 F, quenching in oil or water, and tempering at 1000 to 1300 F. Typical core properties of nitralloy steels are given in Table 3.⁸ Size effects on nitralloy 135 properties are shown in Table 4.⁸

Evaluation

Where the prime purpose of a surface-hardening treatment is to increase resistance to abrasive wear, the most important factors to consider are: 1. Adequate surface hardness of the case. 2. Sufficient excess carbides. In applications where impact may be experienced, an excess of carbides can be detrimental, however, because it promotes spalling. Where the work part is subjected to repeated alternating stresses, the strength factor is predominant and case depth becomes more important than surface hardness.

Strength: The requirement of high strength, both

in the case and the core of a surface-hardened section, relates directly to the type of loading experienced in service. In direct axial loading—either compression or tension—stress is fairly uniform over the entire section. Within the elastic range, the maximum allowable stress on the section would be the same for both case and core. On the other hand, if the work part is subjected to twisting or bending, maximum stress occurs at the surface. As the case depth increases, the ability of the part to withstand this type of loading also increases, Fig. 4.⁹ For example, to increase torsional strength of a 0.5-in. diameter uncarburized steel bar by 25 per cent, Fig. 4 indicates that a case depth of 0.047 in. is required.

Hardenability: Another factor that influences ability to carry torsional loads is case hardenability. Low case hardenability causes soft spots and decreases residual compressive stresses at the surface because of the low amount of transformed martensite within the case structure. Compressive surface stresses are a major factor in improving fatigue properties of surface-hardened parts.

Quenching: Water quenching, particularly when used with large sections or intricate designs, pro-

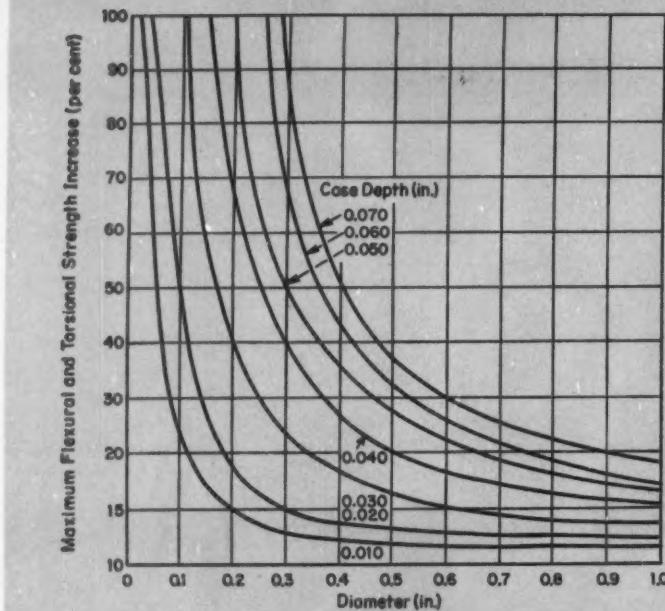
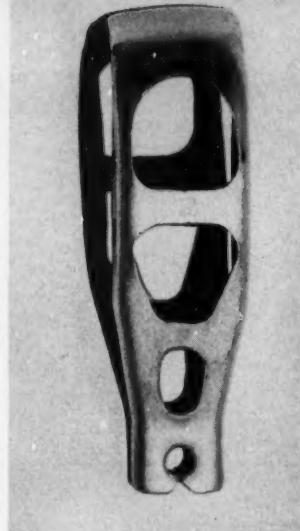


Fig. 4—Increased flexural and torsional strength as a function of case depth for various diameters or section thicknesses.



Carbonitrided case on SAE 1010 clutch release lever is 0.023 to 0.025 in. deep and has a Rockwell A hardness of 80. Surface is uniformly bright and free from scale. Photo, courtesy Ipsen Industries Inc.

Steels for Surface Hardening

Carburizing—Pack, Gas, and Liquid

Carbon Steels

- Normally confined to sections 0.5 in. or less in diameter with base carbon content to 0.25 per cent. Higher carbon steels seldom used because of brittleness of fully quenched core.
- Typical steels: 1010 to 1025, C1110 to C1125, C1320.

Alloy Steels

- For high-hardenability case: 3300, 4300, 4800, and 9300 series with carbon content to 0.25 per cent. Used for heavy sections such as bevel-drive pinions and large gears. Because of excessive austenite in the case, these steels frequently require refrigeration.
- For medium-hardenability case: 1300, 4000, 4100, 4600, 4700, 5100, 6100, 8100, 8600, 8700 series. Also 4422, 4427, 4520, and 94B40. Used for moderate-sized parts, such as gears, pinions, crankshafts, and piston pins.
- For high-hardenability core: 3310, 4320, 4817, 4820, 8822, and 9310.
- For medium-hardenability core: 4032, 4118, 4422, 4427, 4520, 4620, 4621, 4718, 4720, 4815, 5115, 5120, 8620, 8622, 8720, 94B15, and 94B17.
- For low-hardenability core: 4012, 4023, 4024, 4027, 4028, 4615, 4617, 6118, 8115, and 8117.
- For castings: A commonly used cast steel contains 0.15 C, 0.7 Mn, 0.3 Si, 0.25 Mo, and 1.75 Ni (per cent).

Carbonitriding

- Series 1000, 1100, 1300, 3100, 4100, 4600, 5100, 8600, 8700, and 9400 with base carbon content from 0.10 to 0.40 per cent.
- Steels of medium carbon content used for applications requiring heavy loading. Series 5100 used for gears; 8600, for heavy-duty bolts and cap screws.
- Process also used to surface harden tool steels, cast iron, pearlitic malleable iron, and sintered ferrous compacts.

Nitriding

- Any steel that contains nitride-forming elements (aluminum, chromium, molybdenum, vanadium, or tungsten) can be nitrided. Optimum properties of both case and core obtained by using nitralloy steels.
- AISI steels: 4130, 4140, 4340, 8630, and 9440.
- Stainless steels: 302, 304, 321, 347, 416, 410, 420, and 430. Particularly in the austenitic stainless steels, some loss in corrosion resistance can be expected.
- Cast steel: A typical cast-steel composition that can be nitrided contains 0.18 C, 0.5 Mn, 0.4 Si, 2.5 Cr, 0.4 Mo, and 0.20 V (per cent).
- Cast iron: A composition of 2.75 total C, 1.89 graphitic C, 0.86 combined C, 2.58 Si, 0.73 Mn, 1.22 Cr, 0.16 V, 0.24 Mo, and 1.01 Al can be nitrided for use as cylinder liners, sleeves, and bushings. Case depths of 0.008 in. can be achieved in 60 hr.

Flame Hardening

- Typical materials include 1000, 1300, 2300, 3100, 4100, 5100, and 6100 series, with 0.30 to 0.60 per cent carbon.
- Stainless-steel types 410, 416, 420, 440A, and 440B may also be flame hardened.
- All cast irons, with the exception of white iron, may be flame hardened. Degree of hardness depends on percentage of combined carbon (should be 0.25 to 0.85 per cent) or alloy additions. Malleable iron (Rc 42 to 62), ductile iron (Rc 50 to 64), gray iron (Rc 40 to 62), menehanite (Rc 32 to 64) and alloy cast iron (Rc 45 to 65) are included in this group.

*These steels are in the high area of their listed group and sometimes are considered as being in the next higher group.

duces high residual stresses within the part. These stresses tend to distort the section or to cause cracking at notches, keyways, sharp fillets, or other stress raisers. Oil quenching generally reduces distortion, high residual stress levels, and cracking—at the sacrifice of some surface hardness.

Because it is difficult to determine the amount or direction of a residual-stress pattern, a tempering operation is recommended after quenching to reduce the stress level within a surface-hardened section.

Decarburization: When parts are hardened to shallow depths, as in induction hardening, the surface must contain the full complement of carbon to realize maximum surface hardness. For this reason, particularly on hot-rolled bars and forgings where surface diffusion of carbon may occur, conditioning by machining or grinding frequently precedes induction hardening. This pretreatment assures that the base carbon is present at the surface of the section. Special carbon-corrected steels, which require no mechanical conditioning, are available for induction-hardening treatment.

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AC MOTOR CONTROL—4

Starting Multispeed Motors

*How to select controls
for squirrel-cage types*

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and

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MOTORS that provide more than one operating speed offer flexibility as well as convenience in meeting the requirements of many applications. For instance, a ventilating fan may need to be driven slowly in the winter, faster in the summer. Or, a conveyor may require operation at different speeds to vary the amount of material delivered during a given period of time.

The simplest, most economical multispeed drive is the multispeed squirrel-cage motor. However, it has four practical limitations:

1. No more than four speeds are available.

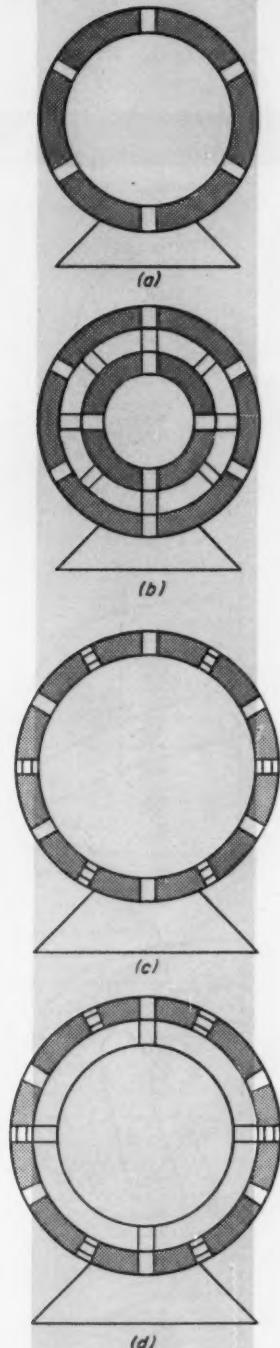


Fig. 1—Methods of indicating typical pole arrangements for 60-cps motors: *a*, single winding, single speed (6 pole, 1200 rpm); *b*, three winding, three speed (6 pole, 1200 rpm; 8 pole, 900 rpm; 4 pole, 1800 rpm); *c*, reconnectable winding, two speed (6 pole, 1200 rpm; 12 pole, 600 rpm); *d*, two winding, three speed, first winding reconnectable (6 pole, 1200 rpm; 12 pole, 600 rpm; 4 pole, 1800 rpm).

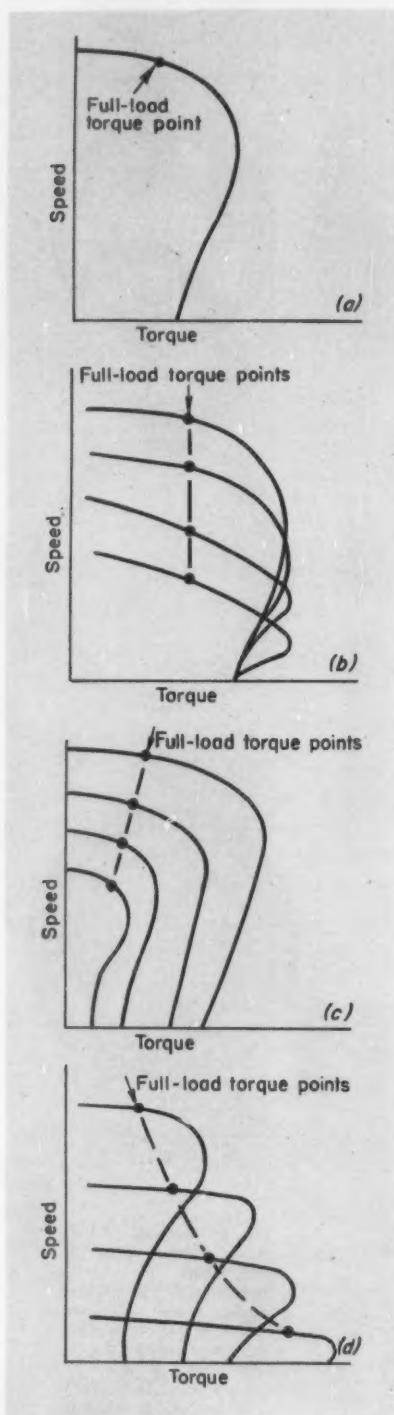


Fig. 2—Typical full-load speed-torque curves for squirrel-cage motors: *a*, single speed; *b*, four speed, constant torque; *c*, four speed, variable torque; *d*, four speed, constant horsepower.

2. Speed ratios greater than 4-to-1 are impractical.
3. Transition between speeds is not inherently smooth.
4. Unusually high torque is not available.

Nevertheless, other features and characteristics make the multispeed squirrel-cage motor a highly versatile drive. Some of the more important motor characteristics, and the controls and circuits for applying multispeed motors, are covered here.

Motor Windings

If two different stator windings are wound on the same motor frame, the result is a two-speed two-winding motor. A motor with four-pole and six-pole windings, for example, provides motor speeds of 1800 and 1200 rpm with a power supply of 60 cps.¹

When a speed ratio of 2-to-1 is acceptable, a two-speed single winding, often called a consequent-pole winding, can be used. Such a motor can be made to operate at either of the two speeds by reconnecting the coils so that the number of effective motor poles is changed. With a consequent-pole motor winding the reconnection always divides or multiplies the number of poles by 2, thus compelling a 2-to-1 speed ratio, such as 3600-to-1800 or 1800-to-900 rpm.

A three-speed two-winding motor has a reconnectable two-speed winding plus a separate winding for the third speed. A four-speed two-winding motor has two stator windings, each reconnectable for two speeds. In three and four-speed motors, the speeds provided by each reconnectable winding have a 2-to-1 ratio. Some common pole arrangements which provide multispeed motor characteristics are shown in Fig. 1.

Torque Characteristics

In addition to speed control, multispeed squirrel-cage motors provide a variety of torque characteristics:

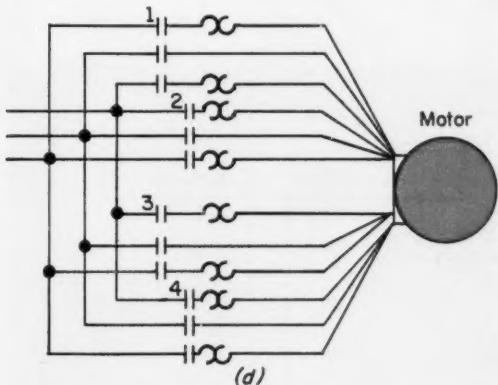
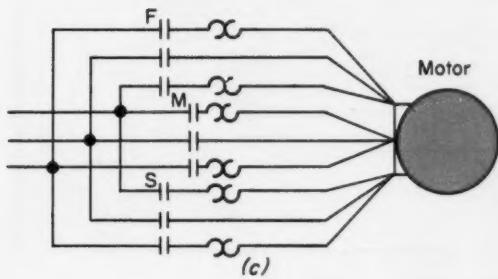
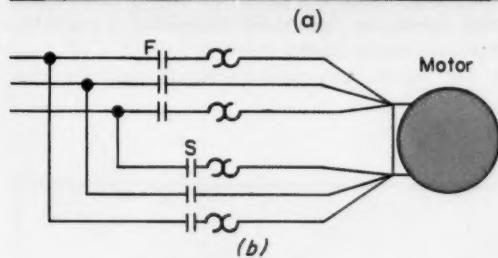
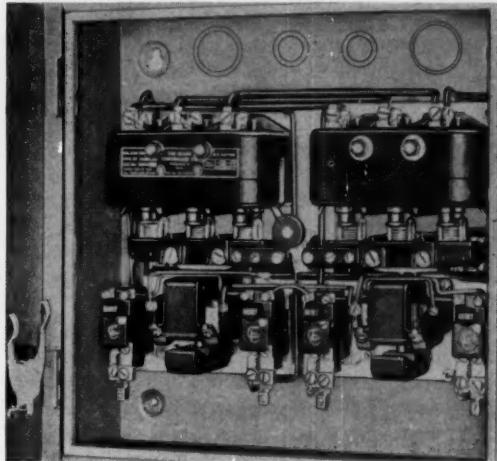
1. Constant torque.
2. Decreasing torque with decreasing speed.
3. Increasing torque with decreasing speed.

Full-load torque is indicated on the speed-torque curve, Fig. 2a, for a typical single-speed squirrel-cage motor. Fig. 2b is the graph for a constant-torque motor. Because this type of motor delivers essentially the same full-load torque at any of its two or more fixed speeds, the full-load torque points on each speed curve can be joined by a vertical line. Constant-torque motors are suitable for driving equipment such as printing presses, conveyors, stokers, grinders, and other machines where torque requirements are about the same for any speed.

A motor which produces decreasing torque with decreasing speed is usually known as a variable-torque motor. A family of speed-torque curves for this type of motor is shown in Fig. 2c. A line joining points of full-load torque slopes toward zero

¹References are tabulated at end of article.

For Separate-Winding Motors



For Consequent-Pole Motors

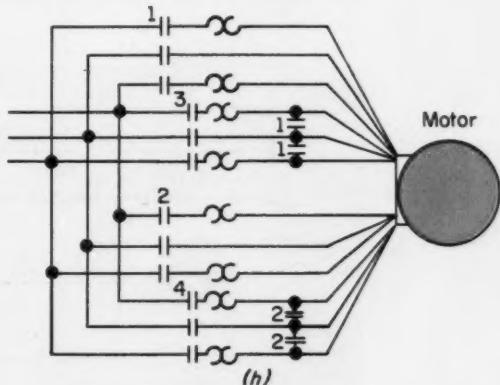
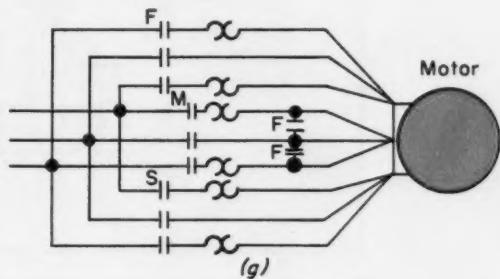
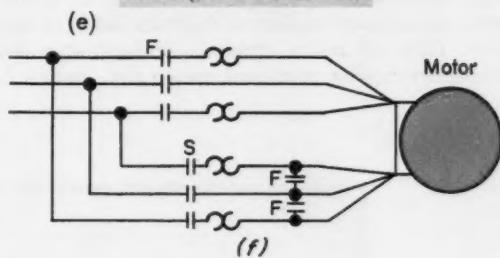
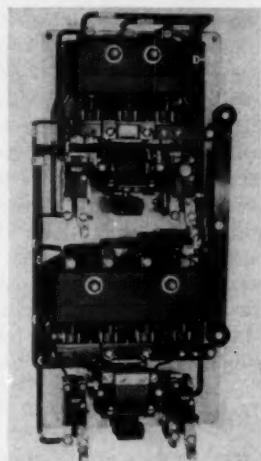


Fig. 3—Typical starters and power circuits for multispeed squirrel-cage motors (not suitable for open-delta motors): *a* and *b*, two speed, two winding; *c*, three speed, three winding; *d*, four speed, four winding; *e* and *f*, two speed, single winding; *g*, three speed, two winding; *h*, four speed, two winding. Three and four-winding motors are not widely used.

torque, thus indicating lower torque at the lower speeds. Such motors are suitable for driving fans, blowers, centrifugal pumps, and other loads where torque requirements decrease as speed is reduced.

The family of curves in Fig. 2d is for a motor whose torque increases as its speed decreases. Therefore, a line joining points of full-load torque slopes toward high torque at zero speed. Motors of this type—constant-horsepower motors—are used on lathes or other machine tools where heavy cuts are taken at low speeds. Light cuts usually are taken at high speeds where reduced torque is satisfactory.

Power Circuits

Specially designed starters are required for multi-speed squirrel-cage motors to meet the needs of different types of motor windings. The starter for a separate-winding two-speed motor, Fig. 3a and b,

consists of two standard three-pole starter units which are electrically (in the control circuit) and mechanically interlocked and assembled in a single enclosure. In Fig. 3c and d, additional three-pole starter units are incorporated for each additional speed. Although these units are always electrically interlocked, it may not be practical to provide mechanical interlocks.

The starter for a consequent-pole motor, Fig. 3e and f, requires a three-pole unit and a five-pole unit. In the starter illustrated in Fig. 3e, the five-pole unit (lower) is basically a four-pole contactor with one movable contact modified by a flexible jumper wire to provide a fifth contact. Instead of a single-circuit double-break contact, the movable contact thus becomes a two-branch circuit with a single-break contact in each circuit. For the type of reconnection required in consequent-pole windings, this arrangement is satisfactory. Fig. 3f represents a starter circuit for a typical consequent-pole motor. However, the design of the winding of a particular motor determines whether the fast or slow-speed connection is made by the five-pole starter unit.

In Fig. 3g a three-pole starter is used for the

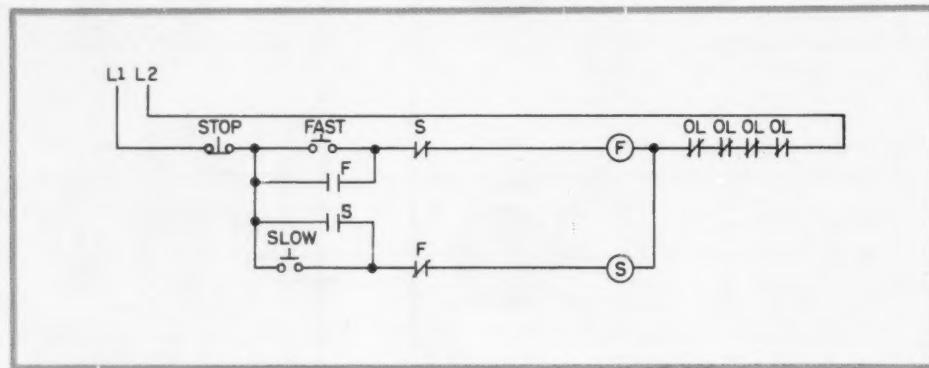


Fig. 4—Control circuit for a two-speed starter. Auxiliary magnetic contacts provide electrical interlocking feature.

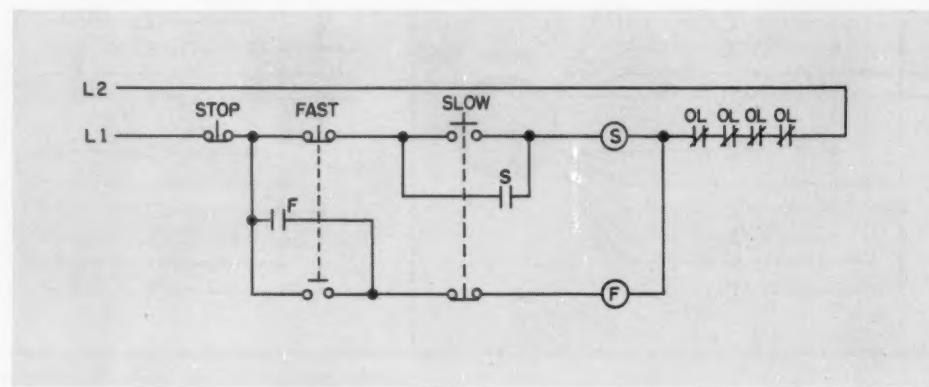


Fig. 5—Control circuit for a two-speed starter with push-button contacts acting as electrical interlocks.

single-speed winding; a five-pole starter and a second three-pole starter handle the reconnectable winding. The four-speed consequent-pole motor, Fig. 3h, requires two sets of three and five-pole starters.

Because currents circulate within the "inactive" or unconnected winding of delta-type multispeed motors, somewhat different power circuits are required. A pair of four-pole starters is required for a two speed motor with separate open-delta windings. An extra four-pole starter is required for each additional speed. Thus, three and four-speed motors with open-delta windings require increasingly complex starters.

Because of differences in multispeed motor windings, specific information concerning the windings must be used to select the motor controls. Torque characteristics of multispeed motors also deserve special attention to assure selection of the proper size of control. Constant-horsepower motors require larger starters than either constant-torque or variable-torque motors of equal horsepower rating. For example, a NEMA Size 3 multispeed starter can be used for a 50-hp, 440-v, constant or variable-torque motor, but the same starter is adequate for only

a 40-hp, 440-v constant-horsepower motor.

When reversing is desired for a multispeed motor, reversing contactors, properly wired in the power lines, will permit the motor to operate in reverse at any speed. If reversing for one speed only is desired, a contactor for the winding or combination of windings providing that speed is all that is required. Of course, mechanical and/or electrical interlocking should be provided with reversing contactors to prevent direct short circuits.

If cushioned starting or limited starting current is desired, features of a primary-resistor starter³ can be included in a multispeed motor starter.

Control Circuits

Depending on the number of speeds and flexibility of operation desired, control circuits may range from simple to complex both in appearance and function. For simplicity, only the control circuits covered in the following discussion are shown. These control circuits may, of course, be used with the power circuits in Fig. 3.

A simple control circuit for a two-speed squirrel-

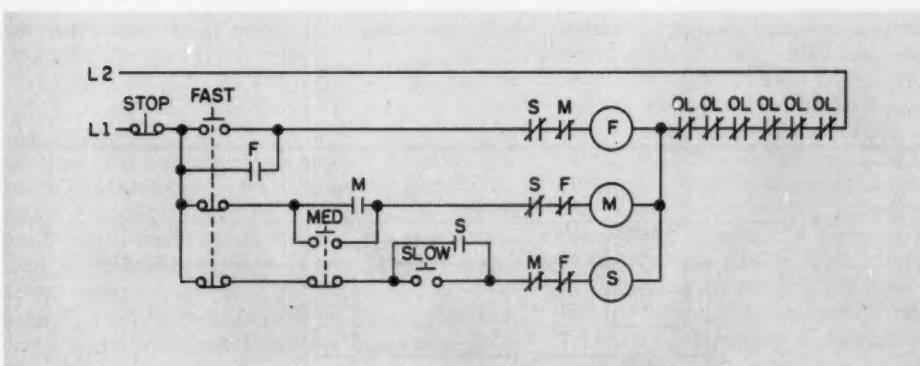


Fig. 6—Control circuit for a three-speed starter. Electrical interlocking is provided both by starter and pushbutton contacts.

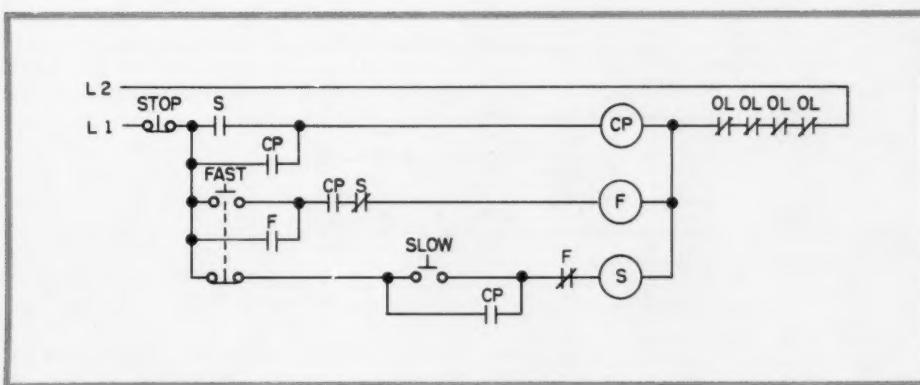


Fig. 7—Control circuit for a two-speed starter with slow-speed-start compelling relay, CP.

cage motor, either of the separate-winding or consequent-pole type, is shown in Fig. 4. The motor can start in either speed, but the electrical interlocks require that the *stop* button be pushed before the speed can be changed. The opposite condition is true in Fig. 5. Here the motor can be started in either speed and then changed to the other speed without first pressing the *stop* button. In this case the pushbuttons act as electrical interlocks.

Fig. 6 shows the control circuit of a starter for a typical three-speed squirrel-cage motor. If the lowest branch of this circuit were deleted, the circuit would represent a two-speed starter. Or, if another branch were added, the result would be a control circuit for a four-speed starter. Features provided by the circuit in Fig. 6 are:

1. Motor can be started at any speed.
2. Higher speed can be obtained without first pressing the *stop* button.
3. Lower speed can be obtained only after pressing the *stop* button.

As indicated, simple variations in a single pushbutton circuit can provide a choice of operating speeds for a multispeed motor. However, a number

of applications demand positive assurance that a motor will not start in a high speed. A prime example is a hoist where a sudden, jolting, high-speed start could snap a cable or otherwise damage equipment or load. To accomplish a slow-start-compelling cycle, the control circuit must include a compelling relay, Fig. 7. Features provided by this circuit are:

1. Motor can be started only in slow speed.
2. Higher speed can be obtained only after *slow* button is pressed.
3. Lower speed can be obtained only after *stop* button is pressed.

Although starting in slow speed is required by the circuit in Fig. 7, an operator who presses the *fast* button immediately after pressing the *slow* button might damage the equipment. To avoid this possibility, a control circuit with an inherent slow start and timed acceleration, Fig. 8, can be used.

In either circuit of Fig. 8, pressing the *fast* button first starts the motor in the slow speed. After a time lapse sufficient for the motor to reach full slow speed, the motor is automatically switched to the high speed. Three and four-speed starters can also be designed for automatic and timed progression of motor speed to any speed initially selected.

Pressing the *slow* button first in Fig. 8 starts and holds the motor in the slow speed until either the

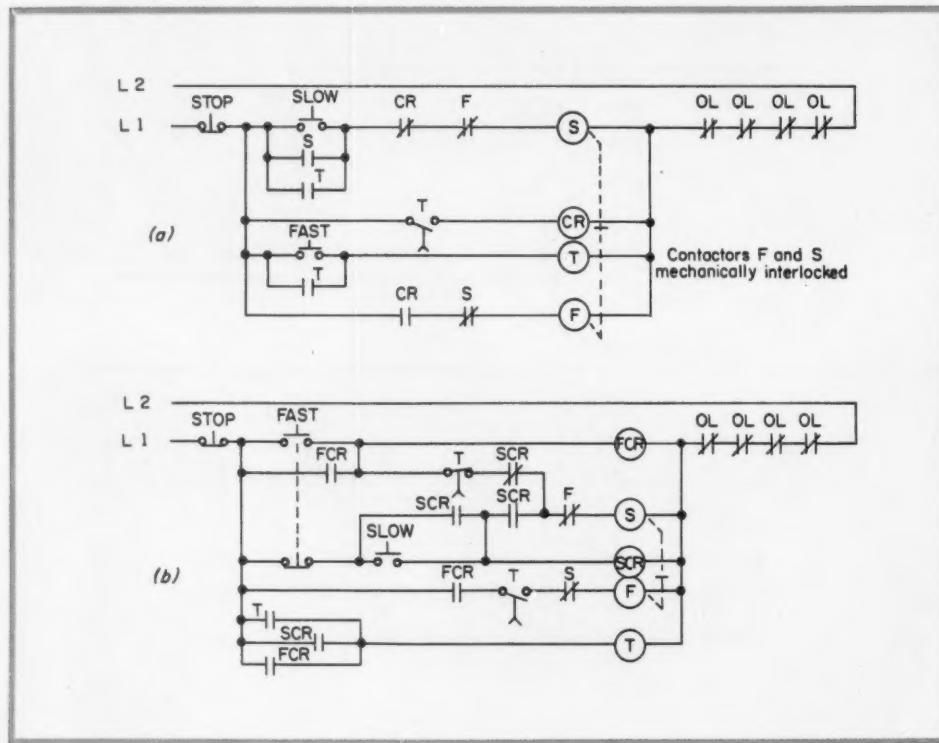


Fig. 8—Two control-circuit designs for two-speed starters which provide inherent slow start and automatic timed acceleration.

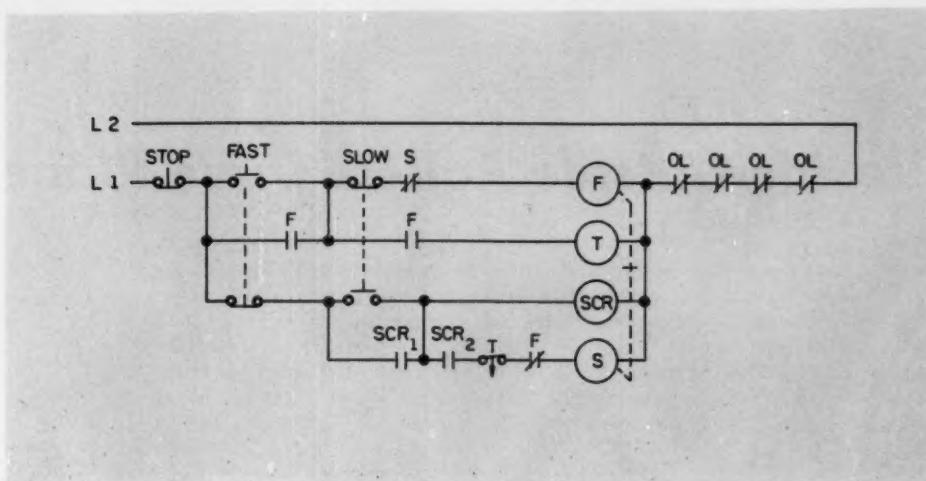


Fig. 9—Control circuit for a two-speed starter with automatic, timed deceleration. Timer contact opens instantaneously when timer relay coil is energized and closes after a time delay which follows coil de-energization.

stop or fast button is pressed. If a careless operator presses the slow and fast buttons in rapid succession, either control circuit would protect the motor and the driven machine by providing a time lapse before the motor changes to high speed.

The only operational difference between Fig. 8a and b occurs when the motor is operating at full slow speed and the fast button is pressed. In Fig. 8b the timer will have timed out so that the motor will switch immediately to the fast speed. Fig. 8a involves a needless time lag. As protection against the shock of regenerative braking, the stop button must be pressed to go into a lower speed in either of the example circuits.

Another control circuit modification may be necessary when regenerative braking becomes a problem. When a motor driving a load at high speed is quickly reconnected to its low-speed winding, the motor exerts a large retarding torque until it reaches the lower synchronous speed. Driven equipment with high inertia, such as a large ventilating fan, places additional strain on the motor and load. Regenerative braking torque of the reconnected motor attempts a sudden reduction in the speed of the driven machinery. If mechanical strain on the equipment is likely to become excessive, timed deceleration is warranted.

The starter control circuit in Fig. 9 provides timed deceleration for protection of driven equipment having high inertia. The motor can be started in either slow or fast speed. In addition, the stop button does not have to be pressed first to change from fast to slow speed as required by the circuits in Fig. 6, 7, and 8. An adjustable time-delay relay disconnects the motor from the power supply until sufficient time has elapsed for the driven machinery to slow to a safe speed relative to the synchronous rating of the lower-speed winding.

If a motor controlled by the circuit in Fig. 9 is operating at the fast speed, pressing the slow button de-energizes contactor coil F and opens the F contacts. Relay T is then de-energized, but normally closed contact T does not close until after a preset time has elapsed. Also, when the slow button is pressed, slow control relay SCR is energized. Thus, contact SCR₁ closes in the holding circuit, and contact SCR₂ closes in the circuit to contactor coil S. However, coil S is not energized until the T contact times out and closes. Power to the motor is disconnected during the timing period. The time lapse permits a high-inertia load to slow sufficiently so that no great shock is produced by regenerative braking torque when the slow winding is energized.

Other combinations of control circuitry can be designed to have compelling and automatic-timing features. Although typical circuits have illustrated the basic principles involved, the particular application and the drive requirements must be considered for proper selection of a starter. The economical multi-speed squirrel-cage motor warrants first consideration when a drive must have more than one operating speed. For applications requiring characteristics other than those offered by multispeed squirrel-cage motors, drives to consider are: 1. Wound-rotor motor. 2. Dc motor operated from a constant-voltage supply. 3. Dc motor operated from an adjustable-voltage supply.

Next article in this series will cover characteristics and control of wound-rotor motors.

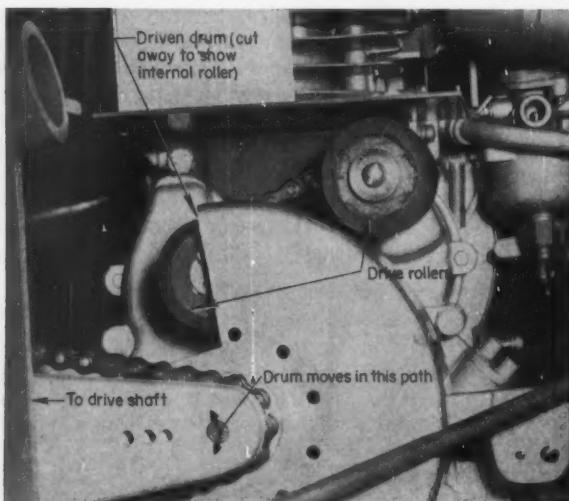
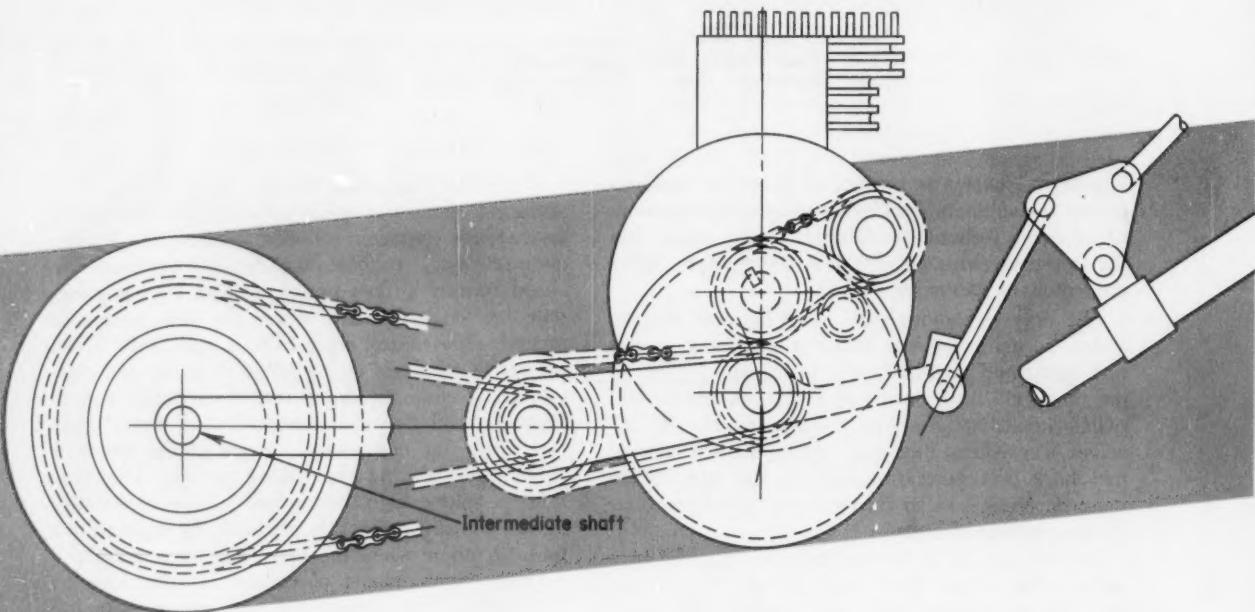
REFERENCES

This article is the fourth in a series by J. Ronald Wickey and Arthur S. Newman Jr. on ac motor control. Previous articles and issues of *MACHINE DESIGN* in which they appeared are:

1. Squirrel-Cage Motors	December 22, 1960
2. Across-the-Line Starting	January 5, 1961
3. Reduced-Voltage Starting	January 19, 1961

Inside-Outside Rollers Drive Plane

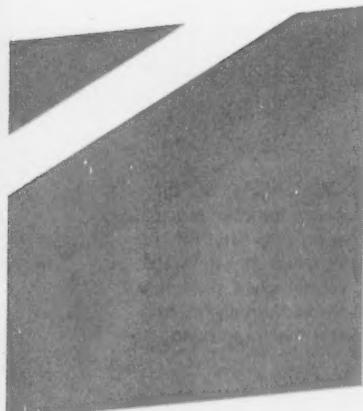
SMOOTH STARTS and stops in forward and reverse are necessary when moving planes in crowded hangers. A new plane mover, no larger than a power mower, combines forward and reverse with a clutching function in one package. Two chain-coupled rollers drive a friction drum on its inside or outside surfaces. Forward or reverse is selected by moving the drum up or down to contact one of the rollers. A fork lift on the vehicle picks up nose or tail wheels of the aircraft to be moved, and weight of the aircraft provides traction for the pint-size tug.



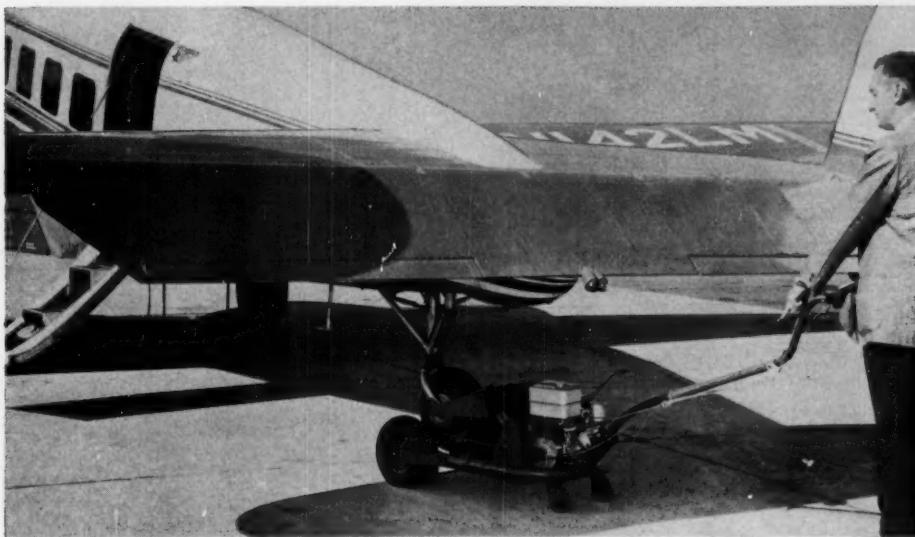
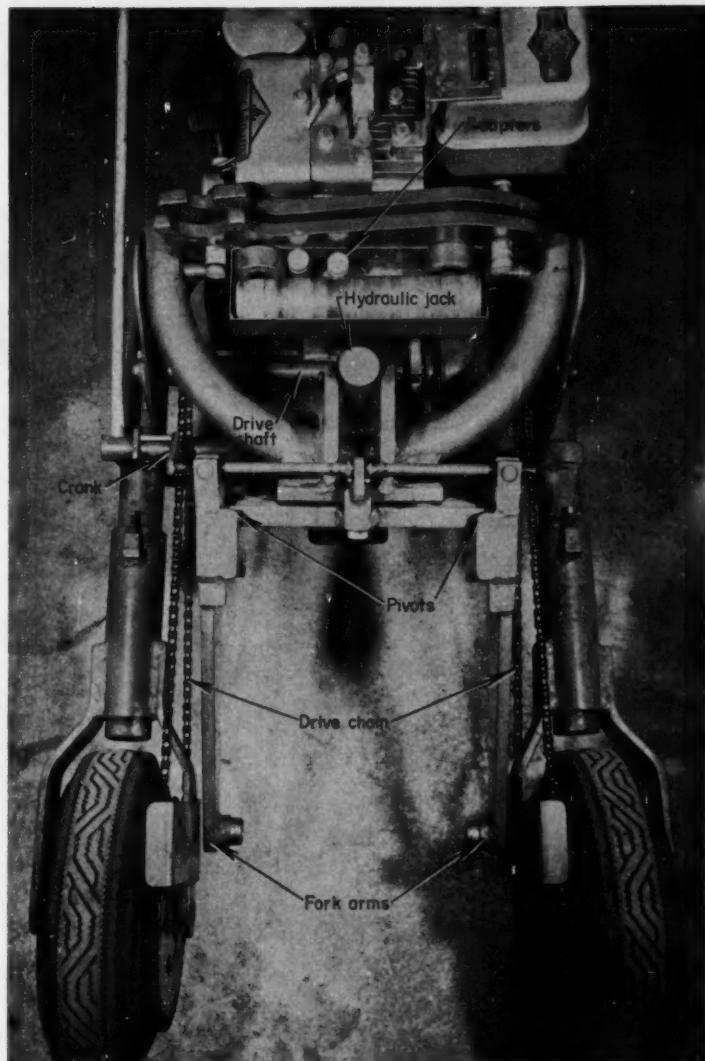
POWER from the air-cooled gas engine is delivered to two chain-coupled drive rollers. Direction of rotation of the driven drum depends on whether the external or the internal roller is in contact. When being shifted, the drum support arm pivots around a drive shaft to which it transmits power through a chain.

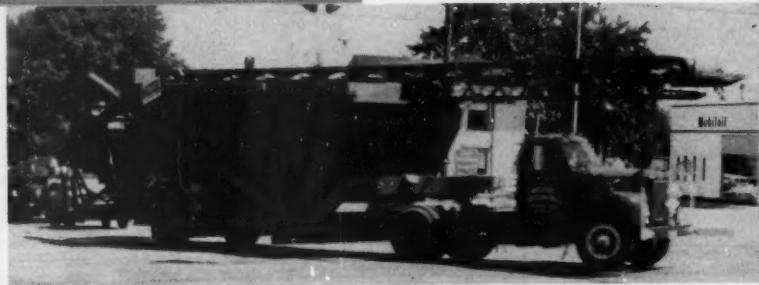
Parker

PIVOTED fork arms are opened or closed by turning a crank on a threaded shaft. Opposite-threaded shaft ends open or close arms simultaneously. Hydraulic jack operates the fork lift. Adapters for various aircraft wheels can be attached to the arms without tools.



PLANE MOVER will handle a wide variety of aircraft. It was developed by Wright Brothers Inc., San Jose, Calif.





FOLDED FOR TRAVEL the batcher measures 37 ft in length and can travel over most modern highways including turnpikes.

Weigh-Down Scale

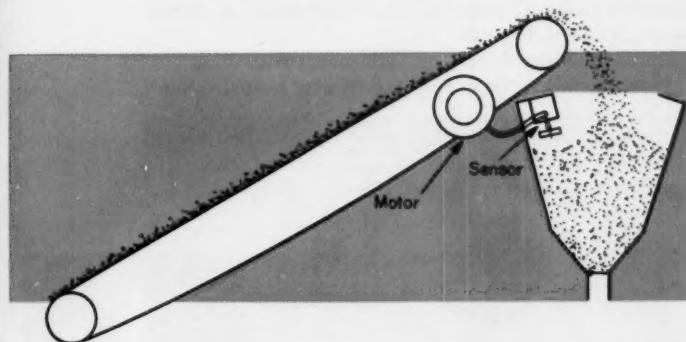
Simplifies Mix

WITH three aggregate hoppers to operate, how do you design a single weighing scale to measure specified quantities from any hopper chosen at random? A new portable cement batcher does it by "weigh-

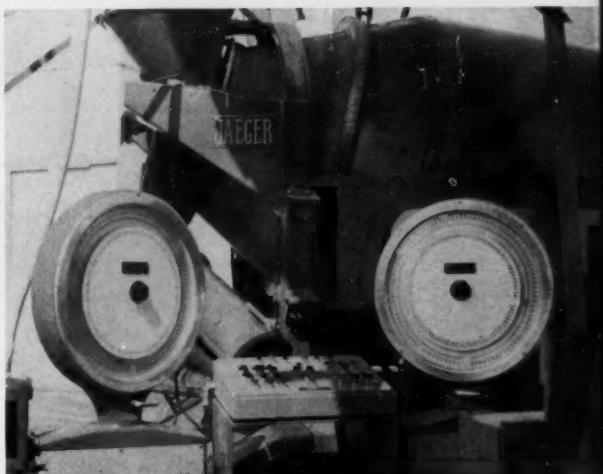
SIMULTANEOUS loading of three bins of a concrete batcher requires no control except a shut-off for each conveyor when its bin is full. Material is not weighed until it is delivered to trucks through the hopper discharge in the foreground.

Control in Portable Concrete Batcher

ing down." Hoppers for sand and two grades of gravel are supported on a single weighing platform. Weight of all aggregate loads the scale. Aggregate is released from one hopper at a time and measured by loss of weight as the scale pointer moves down. A separate hopper stores cement and is weighed on its own scale. Because of the lumping characteristics of cement, it is fed into the hopper via enclosed worms.



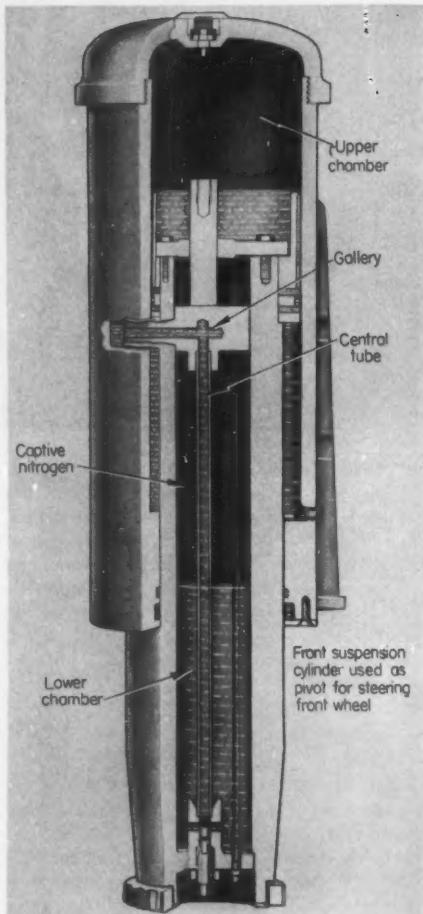
PADDLE-WHEEL sensor shuts off conveyor motor when bin is full. While conveyor is running, a tiny motor spins the paddlewheel. When aggregate reaches the paddlewheel, it stalls the paddles and the motor winds up a spring coupling to break contact in the conveyor-motor line.



INNER SCALE on the dials is set before weigh-down operation so that zero coincides with the position of the pointer. As a hopper is discharged, pointer indicates on the inner scale the weight of material discharged. Outer scale reads combined weight of the contents of the three hoppers. Scale on the right weighs aggregate; that on the left weighs cement. Control panel operates dump gates in hoppers and conveyor motors.

HYDRAULIC PISTON raises the batcher into working position. Struts support the load of the hopper during operation. The concrete batcher was developed by Heltzel Steel Form & Iron Co., Warren, Ohio. Hydraulic cylinder used in erection is from Commercial Shearing & Stamping Co.

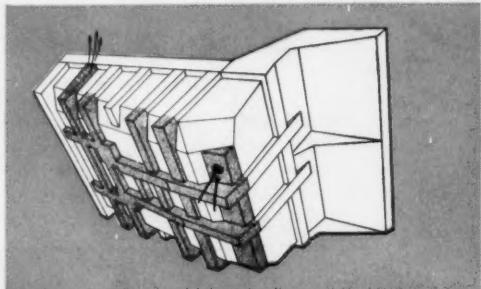
Box Girders Make Heat Flues In



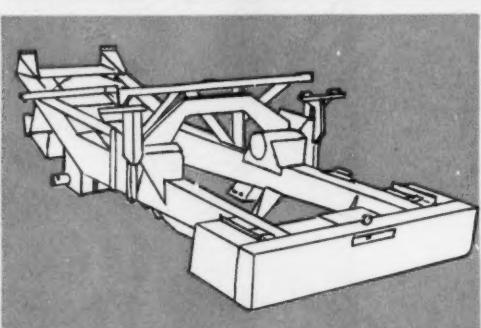
DOUBLE-FUNCTION designing has produced a new dump truck able to carry nearly twice its weight in payload. Short wheel base and an unconventional hydraulic steering linkage make the vehicle extremely maneuverable in cramped quarters. New features include:

1. Pneumatic-hydraulic suspension cylinders, doubling for springs and shock absorbers, form pivots for steering front wheels.
2. Vulnerable hydraulic steering joints and links are moved away from dirt and splash.
3. Structural members double as high-pressure air tank.
4. Box frame members act as flue passages for heated exhaust gases.
5. Thermostatically controlled fan operates only when needed — conserving power and heat.

The new 60-ton dump truck is a development of LeTourneau-Westinghouse, Peoria, Ill.



BOX GIRDERS in the body double as ducts to carry hot exhaust fumes along the floor of the body, keeping frozen loads from sticking.

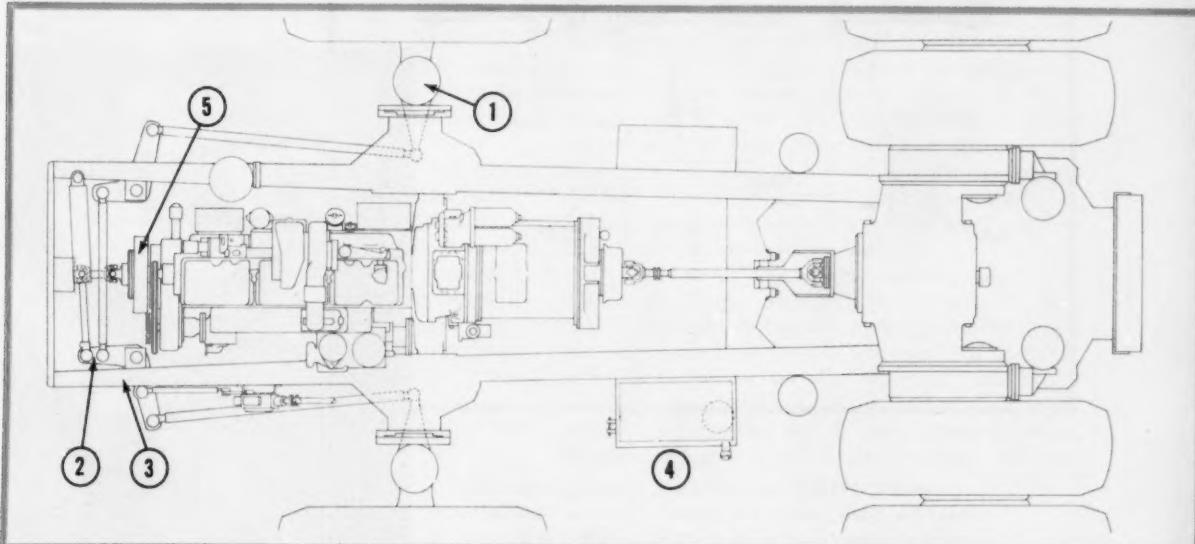
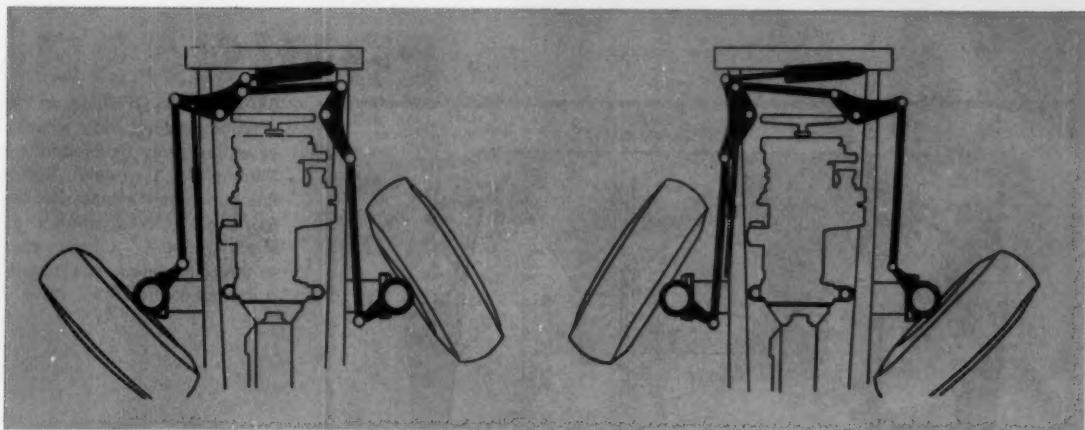


DOUBLE DUTY is performed by framework of front suspension, which is also high-pressure air reservoir for braking system.

SUSPENSION CYLINDER supports the vehicle on a cushion of captive nitrogen. Oil lubricates the piston and helps seal gas between upper and lower chambers. It also acts as a snubber by absorbing energy as it flows between sump and lower chamber. As the piston moves in the cylinder, oil flows between the sump and the lower chamber through the central oil tube and the connecting gallery, absorbing energy as it flows. Front-wheel suspension cylinders act as pivots for steering.

Hefty Dump Truck

BELL CRANKS take the place of the usual four-bar steering linkage. Pivoting joints are brought forward to locations accessible for servicing. The hydraulic cylinder is safely tucked behind the front bumper frame.

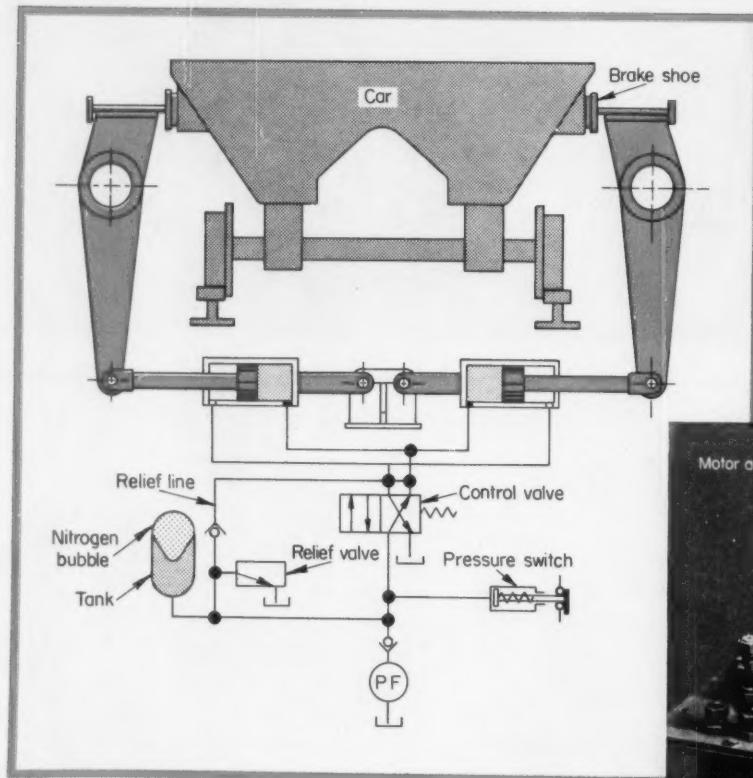




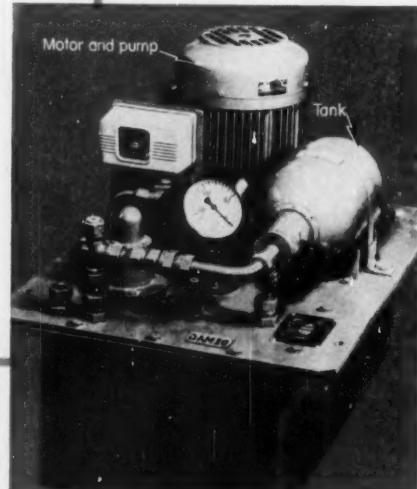
Car-Grab Shocks

Absorbed by Nitrogen Bubble

CAR GRAB, consisting of two brake shoes paralleling a track, is normally in a closed position. Shoes, under pressure, are forced apart by the arriving car. Cam surfaces at the ends of the shoes permit the car body to wedge itself between them under force of its momentum. Shock in the brake's hydraulic system caused by forcing the shoes apart is absorbed by a nitrogen bubble in the pressure tank. Extreme pressure pulses are dissipated through a relief valve.



HYDRAULIC SYSTEM is contained in a package that drops into the floor under the tracks. Cam surfaces allow gradual energy absorption as cars slide into the car grab.



A comparative analysis of commonly used

PIVOT THRUST BEARINGS

F. W. KINSMAN

Mechanical Consulting Engineer
Penfield, N. Y.

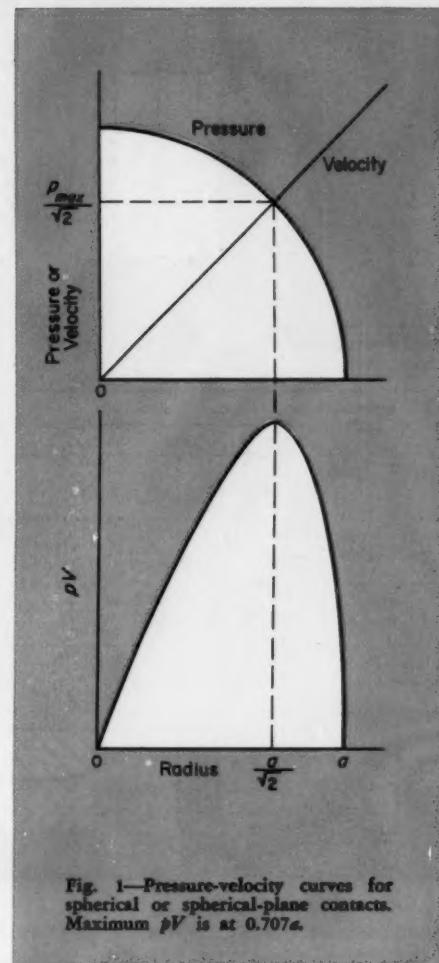


Fig. 1—Pressure-velocity curves for spherical or spherical-plane contacts. Maximum pV is at 0.707a.

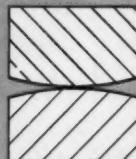
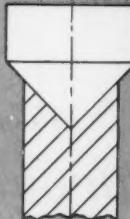
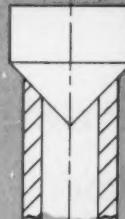
SMALL pivot thrust bearings, in the form of buttons, pads, or cones, provide a virtually friction-free support. Because of their small size—generally up to 1 in. diameter—they can be made of materials that are usually impractical for large bearings.

Among the more exotic materials used for these pivots are diamonds and sapphires. For most applications, however, high cost and manufacturing difficulties prohibit their use except in small, relatively simple configurations. Materials used where economy is of prime importance are steel and glass. Sintered carbide is also an important material for pivot bearings. It can be produced either with a very high hardness or with a high degree of toughness, at the expense of some of its hardness. It is also possible to use sintered-carbide thrust bearings as sintered, without subsequent polishing.

Table 1 illustrates the various types of small thrust bearings discussed in this article, and lists pertinent formulas. These bearings may be inexpensive and compact, and are many times as efficient as thrust collars, although there are instances where thrust collars must be used. These are discussed here primarily for purposes of comparison. Although pivot bearings use direct contact rather than rolling or fluid contact, they are often as efficient as roller or fluid-film thrust bearings.

The product pV , which represents the power dissipated per square inch of bearing area, is often used in establishing whether or not a bearing design has adequate load-carrying capacity. In ordinary radial bearings, the surfaces of either the shaft or bearing have a brief chance to cool between contacts. This is not the case in thrust bearings; hence, the allowable pV values for thrust bearings are low-

Table 1—Equations for Pivot Thrust Bearings



Case 1

Case 2

Case 3

Case 4

Case 5*

1. Maximum bearing pressure, p_{max} (psi)	$\frac{0.32 F}{a^2 - a_i^2}$	$\frac{0.32 F}{a^2}$	$\frac{0.32 F}{a^2 - a_i^2}$	$\frac{0.32 F}{a^2}$	$\frac{0.48 F}{a^2}$
2. Bearing pressure at radius r , p (psi)		Pressure assumed uniform and equal to p_{max}			$p_{max} \frac{(a^2 - r^2)^{1/2}}{a}$
3. Velocity, V (fpm)			0.524 rN		
4. Maximum pressure-velocity product $(pV)_{max}$	$\frac{0.167 FaN}{a^2 - a_i^2}$	$\frac{0.167 FN}{a}$	$\frac{0.167 FaN}{a^2 - a_i^2}$	$\frac{0.167 FN}{a}$	$\frac{0.125 FN}{a}$
5. Friction torque (lb-in.)	$0.67 fF \left[\frac{a^3 - a_i^3}{a^2 - a_i^2} \right]$	$0.67 fFa$	$0.67 fF \left[\frac{a^3 - a_i^3}{a^2 - a_i^2} \right]$	$0.67 fFa \sin \alpha$	$0.59 fFa$
6. Power loss, P (lb-in./sec)	$0.070 fFN \left[\frac{a^3 - a_i^3}{a^2 - a_i^2} \right]$	$0.070 fFaN$	$0.070 fFN \left[\frac{a^3 - a_i^3}{a^2 - a_i^2} \right]$	$0.070 fFaN \sin \alpha$	$0.062 fFaN$

$$*a = 0.88 \left[\frac{F \left(\frac{1}{E_1} + \frac{1}{E_2} \right)}{\frac{1}{r_1} + \frac{1}{r_2}} \right]^{1/2}$$



Case 6

Identical to Case 5 with $1/r_2 = 0$.

er than those for comparable radial bearings. Also, in radial bearings lubricant is more likely to be present between the contacting areas. Fig. 1 presents pressure and velocity characteristics for spherical or spherical-plane contacts.

In analyzing cases 5 and 6, it is assumed that spherical surfaces are convex. If one of them is concave, the sign of its radius of curvature should be taken as negative in the applicable equations.

A comparison can be made between spherical and flat pivot bearings. Assuming equal thrust loads, F , and assuming that the curvatures in the spherical pair have been adjusted so that the contact areas in the two pairs are equal, a comparison of the applicable equations leads to the following conclusions: 1. The maximum pressure in the spherical pair is 50 per cent greater than in the plane pair. 2. Maximum pV is 33 per cent greater in the plane pair. 3. The spherical pair is about 11 per cent more efficient than the plane pair.

It makes no difference whether the spherical combination is convex-convex, convex-plane, or convex-concave.

The equations in Table 1 give only compressive stresses. However, since shear and tensile stresses

Nomenclature

a = Outside radius of surface of contact, in.

a_i = Inside radius of surface of contact, in.

E_1, E_2 = Moduli of elasticity of two contacting-surface materials, psi

F = Axial thrust load on bearing, lb

f = Coefficient of friction

N = Rotational speed, rpm

P = Power loss, lb-in./sec

p = Pressure or compressive stress, psi

r = Radius at any point on surface of contact, in.

r_1, r_2 = Radii of curvature of contacting spherical surfaces, in.

V = Velocity, fpm

α = Angle of bearing surface with centerline of shaft, deg

resulting from thrust loads are proportional to the compressive stresses, the equations for compressive stress can be used to compare similar bearings.

ACKNOWLEDGMENT

The author acknowledges with appreciation the co-operation of Mr. R. J. Procaccino in preparing this article.

Charts simplify calculation of coefficients for

Air-Gap Heat Transfer

J. I. GONZALEZ

Design Engineer
Thermodynamics Staff
The Martin Co.
Orlando, Florida

HEAT-TRANSFER analyses frequently require calculation of an over-all heat-transfer coefficient for air gaps. This coefficient represents the heat flow across an air gap by convection, conduction, and radiation.

Nomenclature

F_e = Configuration factor (including effect of emissivity and geometry)
F_A = Shape modulus (function of geometry only)
g = Gravitational acceleration, 32.174 ft/sec/sec
H = Height of vertical plate or gap, in.
h = Heat-transfer coefficient, Btu/hr/sq ft/deg F
K = Thermal conductivity, Btu/hr/ft/deg F
L = Gap width, in.
N_{Gr} = Grashof number (Equation 2)
Q = Heat flux, Btu/hr/sq ft
T_{AV} = Average temperature of hot and cold sides of air gap, F
T_C = Cold-side temperature of air gap, F
T_H = Hot-side temperature of air gap, F
U = Overall heat-transfer coefficient, Btu/hr/sq ft/deg F
U_{c,e} = Overall heat-transfer coefficient for conduction and convection, Btu/hr/sq ft/deg F
U_{rad} = Overall heat-transfer coefficient for radiation, Btu/hr/sq ft/deg F
β = Coefficient of thermal expansion, per deg Rankine
ε_C = Emissivity of cold side surface
ε_H = Emissivity of hot side surface
ν = Kinematic viscosity, sq ft/sec
σ = Stefan-Boltzmann constant, Btu/hr/sq ft/(deg Rankine)⁴

Values of such coefficients for either vertical or horizontal air gaps can be determined easily for many design situations with the aid of charts provided here. Symbols are defined in Nomenclature.

Convection and Conduction

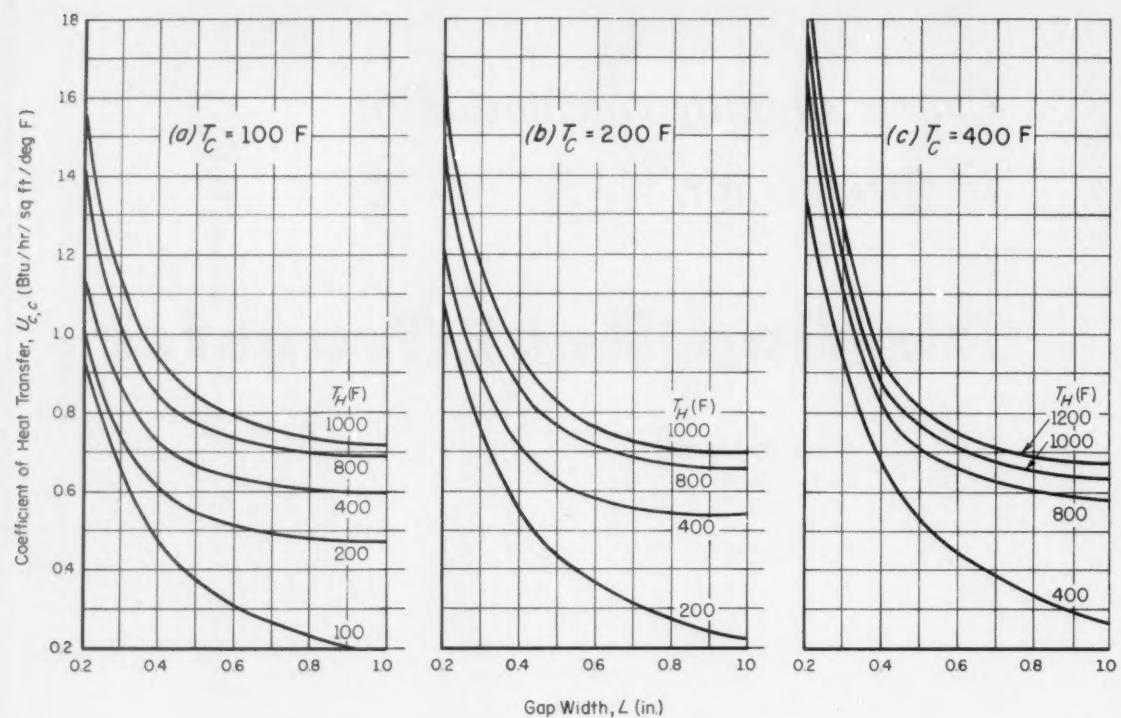
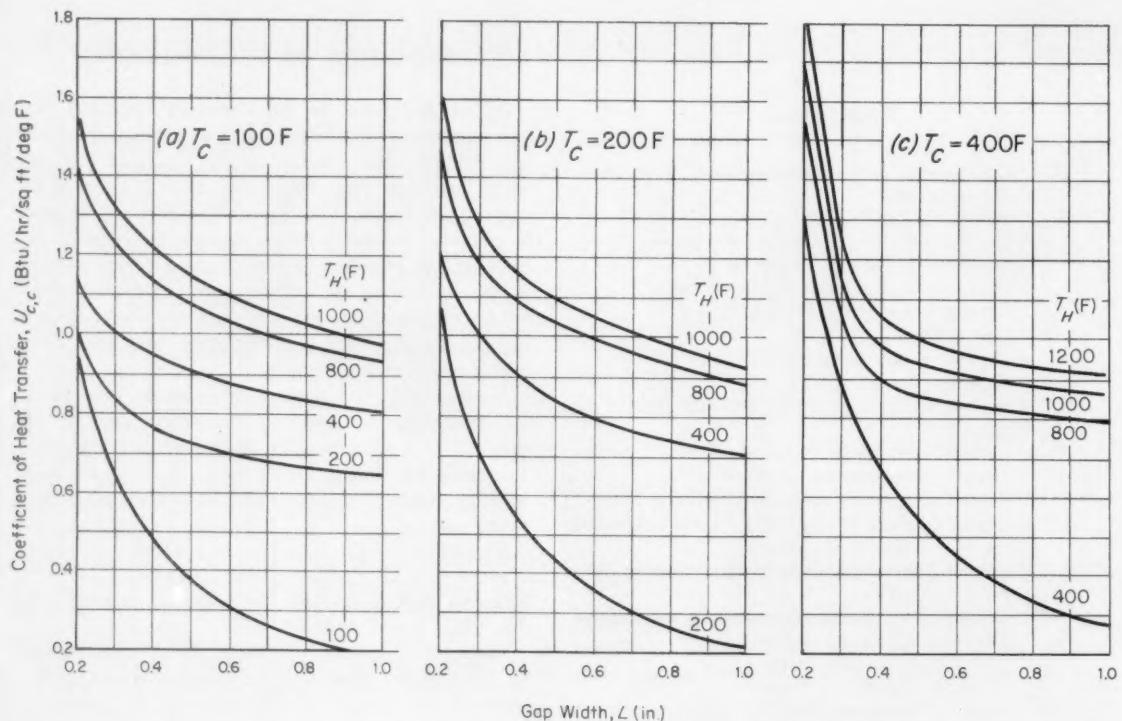
All of the charts for heat transfer by convection and conduction are based on a gap pressure of one atmosphere (14.7 psi). Unless the gap pressure varies markedly from this value there is no need for a correction factor. The thermal conductivity of gases is virtually independent of pressure in a range not too far from atmospheric conditions. For heavy gases, **K** can be considered independent of pressure above 1 mm Hg; for hydrogen and helium, above 20 mm Hg. The upper limit of such dependency may be at one or more atmospheres.

In the convection process, for example, heat-transfer coefficient **h** varies as the square root of the pressure (for air pressures other than atmospheric). To verify the magnitude of error, the over-all heat-transfer coefficient, **U_{c,e}**, may be computed from

$$U_{c,e} = h + \frac{K}{L} \quad (1)$$

where **h** and **K** include the effect of pressure and the units are consistent.

A useful concept in the analysis of heat transfer by gases is the dimensionless Grashof number, **N_{Gr}**, which is mathematically defined and is directly related by the principle of similarity to the well-known Reynolds number for fluid flow. Experi-

Fig. 1—Heat-transfer coefficient $U_{c,c}$ for vertical air gaps.Fig. 2—Heat-transfer coefficient $U_{c,c}$ for horizontal air gaps.

mental data are lacking for Grashof numbers corresponding to gap widths in the range between 0.3 and 0.4 in. For gap widths of 0.3 inch and less, conduction and radiation are the primary modes of heat transfer and the effect of convection is negligible.

Vertical Air Gaps: Values of $U_{c,0}$ for vertical air gaps which are 8 in. high and have cold-side temperatures of 100, 200, or 400 F can be read directly from the charts in Fig. 1a, b, or c, respectively. For gap heights other than 8 in., the following procedure is recommended:

1. Compute Grashof number N_{Gr} from

$$N_{Gr} = \frac{\beta g L^3 (T_H - T_C)}{y^2} \quad (2)$$

where

$$\beta = \frac{1}{T_{AV}}$$

and

$$T_{AV} = \frac{T_H + T_C}{2}$$

These relationships are based on the assumption that deviations from the conditions of a perfect gas are negligible.

2. If the value of N_{Gr} falls in the range $20,000 \leq N_{Gr} \leq 200,000$, compute the corrected coefficient from

$$U_{c,c'} = U_{c,0} \left(\frac{8}{H'} \right)^{1/9} \quad (3)$$

where $U_{c,c'} =$ the corrected over-all heat-transfer coefficient for an air gap with height other than 8 in., $U_{c,0} =$ chart value of heat transfer coefficient for 8-in. high air gap, and $H' =$ air-gap height.

3. If the value of N_{Gr} is less than 20,000 or greater than 200,000, special calculation techniques are required. These techniques are treated in detail by Jakob.¹

Horizontal Air Gaps: Fig. 2a, b, and c apply to horizontal air gaps. Data are plotted for cold-side

¹References are tabulated at end of article.

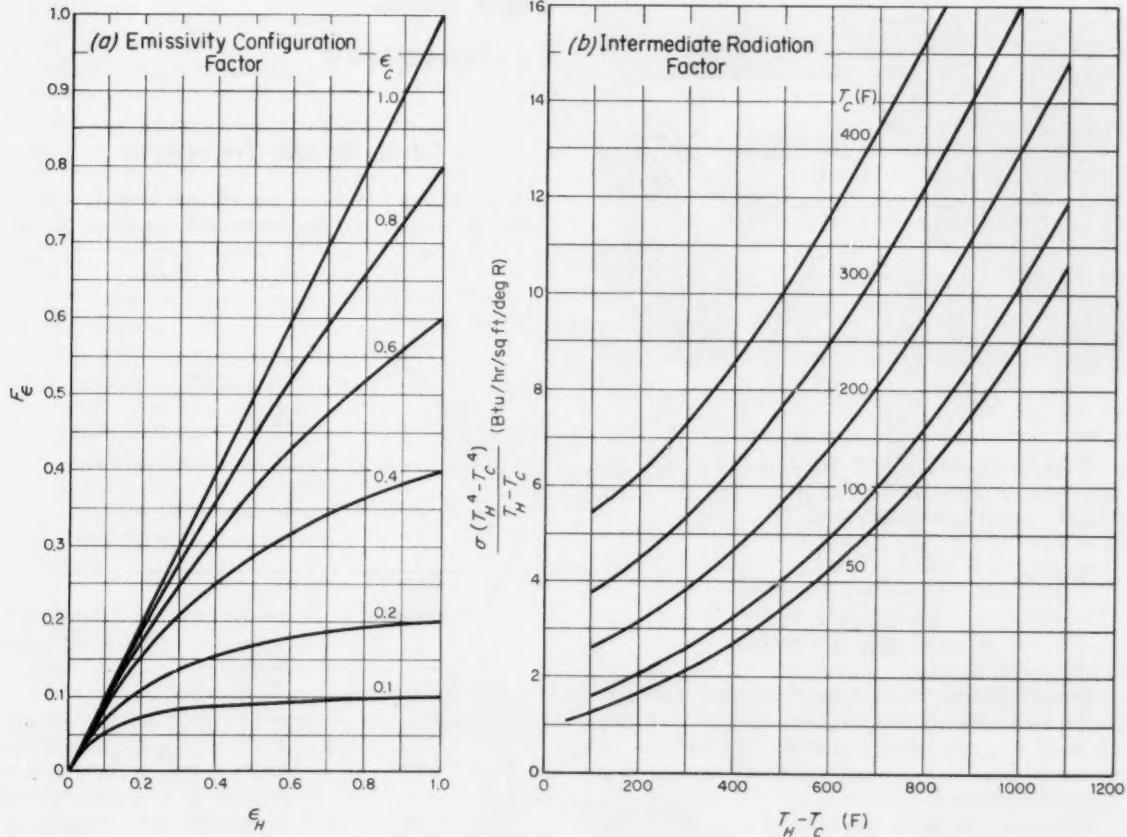


Fig. 3—Factors for calculation of U_{rad} across an air gap between two infinite parallel planes.

temperatures of 100, 200, and 400 F, respectively.

Radiation

The value of heat-transfer coefficient U_{rad} across either vertical or horizontal air gaps can be determined with the aid of Fig. 3. The radiation data given here are limited to the general case of two infinite parallel planes: $F_A = 1$. For finite parallel planes, shape modulus F_A is less than one.²

The general relationship for heat transfer by radiation under the previous conditions is

$$Q = \sigma F_e F_A (T_H^4 - T_C^4) = U_{rad} (T_H - T_C) \quad (4)$$

or, by rearranging terms,

$$U_{rad} = \frac{\sigma F_e F_A (T_H^4 - T_C^4)}{T_H - T_C} \quad (5)$$

where T_H and T_C are expressed here as absolute (Rankine) temperatures.

The value of F_e is given as a function of ϵ_H and ϵ_C in Fig. 3a. The intermediate radiation factor,

$$\frac{\sigma (T_H^4 - T_C^4)}{T_H - T_C}$$

is given as a function of $T_H - T_C$ in Fig. 3b.

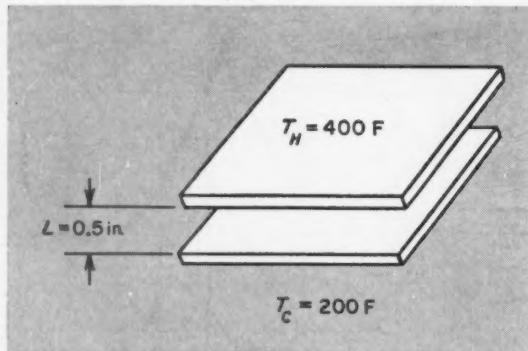


Fig. 4—Air-gap geometry for example solution.

To determine U_{rad} , find the values of F_e and the intermediate radiation factor from Fig. 3. Then, from Equation 6, assuming $F_A = 1$,

$$U_{rad} = F_e \left[\frac{\sigma (T_H^4 - T_C^4)}{T_H - T_C} \right] \quad (6)$$

Example Solution

Determine the overall heat-transfer coefficient across a horizontal air gap, Fig. 4, with one face at 400 F and the other at 200 F. Gap width $L = 0.5$ in. Assume that $\epsilon_H = \epsilon_C = 0.2$ and that the faces are infinite planes.

For a horizontal air gap with $T_C = 200$ F, the chart in Fig. 2b is used to find $U_{c,c}$. From this chart at $L = 0.5$ in. and $T_H = 400$ F, $U_{c,c} = 0.855$

Btu/hr/sq ft/deg F.

By definition, $U_{c,c}$ does not include the effect of radiation. From Fig. 3a at $\epsilon_H = 0.2$ and $\epsilon_C = 0.2$, $F_e = 0.11$. From Fig. 3b at $T_H - T_C = 200$ and $T_C = 200$ F,

$$\frac{\sigma (T_H^4 - T_C^4)}{T_H - T_C} = 3.15 \text{ Btu/hr/sq ft/deg R}$$

From Equation 6, $U_{rad} = 0.11 (3.15) = 0.347$ Btu/hr/sq ft/deg F. Thus, the overall coefficient of heat transfer, U_{tot} , for the air gap is

$$U_{tot} = U_{c,c} + U_{rad} = 0.855 + 0.347 \\ = 1.20 \text{ Btu/hr/sq ft/deg F}$$

Total heat transfer across the air gap can now be evaluated from the general relationship, $Q_{tot} = U_{tot} A (T_H - T_C)$ where Q_{tot} is the total heat flow (Btu/hr) through a given area A .

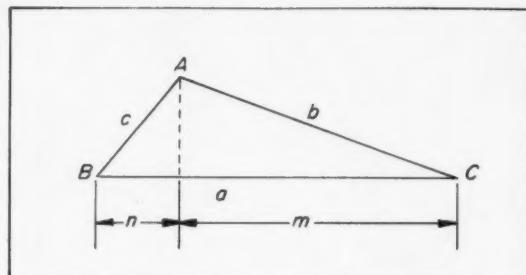
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1. M. Jakob—*Heat Transfer*, Vol. 1, John Wiley & Sons Inc., New York, 1949, p. 538.
2. D. C. Hamilton and W. R. Morgan—“Radiant-Interchange Configuration Factors,” *NACA Technical Note TN 2836*, December, 1952.

Tips and Techniques

Solving Oblique Triangles

When all three sides of an oblique triangle are given, the angles can be found without using the Law of Cosines.



First, determine

$$p = \frac{b^2 - c^2}{a}$$

Then

$$m = \frac{a + p}{2} ; n = \frac{a - p}{2}$$

When m and n are known, the angles can be found by using 90-deg triangle relationships.—M. W. LOFTUS, Chicago, Ill.

Loosening of Bolted Joints

by small plastic deformations

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UNINTENDED loosening of bolted joints is unfortunate no matter why it happens. One of the most common ways is by plastic elongation of the bolt. Such plastic deformation will occur whenever the stress in the bolt exceeds the elastic limit. Obviously, this can be prevented by keeping peak stresses below the elastic limit at all times, but this solution is not always practical or economical. For efficient use of bolts, clamping forces should be as high as possible, and it is common practice to tighten bolts initially to stresses near or even above the elastic limit. Furthermore, it may be anticipated that requirements for bolted-joint applications of the future will be increasingly severe, necessitating minimum factors of safety while demanding maximum reliability. These conditions indicate a need for methods by which the amount of loosening may be predicted quantitatively. The same methods should permit rational determination of the best means of mitigating loosening in a particular application.

Loosening by External Force: A bolted joint loaded in tension may be visualized as shown in Fig. 1a. The bolt is tightened initially to tension F_1 , creating clamping force F_{c1} at the mating surfaces. When the external force P is applied, the bolt tension increases from F_1 to F_2 while the clamping force decreases from F_{c1} to F_{c2} . The free-body diagram is shown in Fig. 1c, and the equilib-

rium equation is $F_2 = P + F_{c2}$.

As the bolt load increases from F_1 to F_2 , the bolt elongates an amount ΔX_b . At the same time, the compressive force on the f-portion of the clamped parts increases from F_1 to

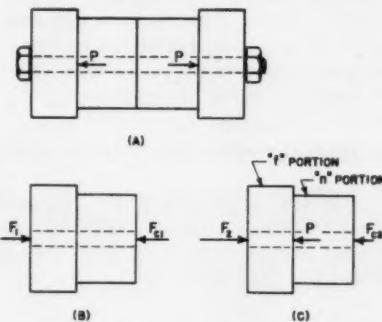


Fig. 1—Bolted joint loaded in tension.

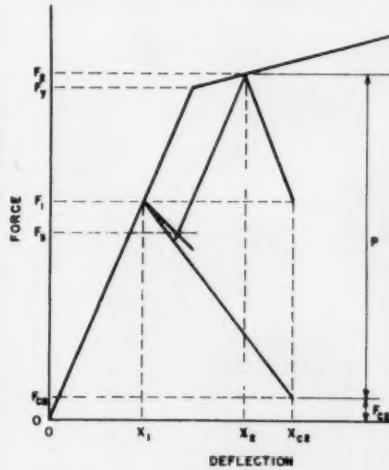


Fig. 2—Typical force-deflection diagram for bolted joint with initial tension below the elastic limit.

F_2 , resulting in a contraction of ΔX_{cf} . Also, the compressive force on the n-portion decreases from F_{c1} to F_{c2} , hence it elongates an amount ΔX_{cn} . The total springback of the clamped parts is the difference between ΔX_{cn} and ΔX_{cf} . As long as the mating surfaces do not separate, the bolt elongation must equal the clamped parts springback. Hence, the necessary deflection relation is $\Delta X_b = \Delta X_{cn} - \Delta X_{cf}$.

For a particular case, the foregoing relationships may be shown conveniently on a force versus deflection diagram, Fig. 2. For this case, initial tightening load F_1 is less than the elastic-limit load F_y , the maximum bolt load F_2 is greater than F_y , and the clamping force F_{c2} is greater than zero. Therefore, the mating surfaces do not separate.

For equilibrium, the final bolt tension F_3 must equal the final clamping force F_{c3} . These forces are found at the intersection of the respective lines.

As a result of the first application of external force, loosening has occurred, and the bolt tension has decreased from F_1 to F_3 .

After a second application of external force, it will be found that F_2 equals F_y . Since F_2 does not exceed F_y during the second load application, no plastic deformation of the bolt occurs, and there is no loosening. Repetitions of the same external force will cause no further loosening.

Results of sample calculations for several bolted joints are plotted in Fig. 3. In general, the curves show

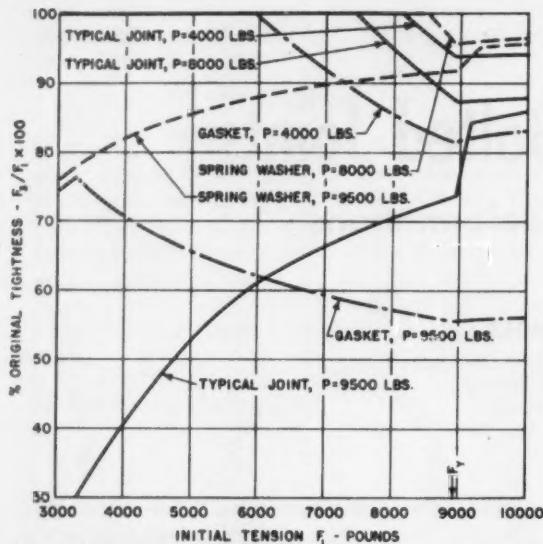


Fig. 3—Effects of initial tension, gaskets, and spring washers on loosening due to external force.

that if loosening is to be completely avoided for small or moderate values of external load, the initial tension must not exceed a prescribed maximum value. On the other hand, loosening is unavoidable at extremely high values of external load, but the amount of loosening can be decreased by tightening to higher values of initial tension. It can be seen that the spring washer results in substantially decreased loosening in all instances.

It should be noted that some

bolted joints may be subjected after fabrication to a test load much higher than the external load expected in service. Possible loosening due to the test load should not be overlooked. Also, it is obvious that lock-nuts or similar devices cannot be effective against the type of loosening under discussion.

Loosening by External Impact: An external impact load, such as that caused by the collision of two moving bodies, will require the

bolted joint to absorb a certain amount of energy.

For a given impact energy W , there is a maximum initial tension which should not be exceeded during tightening if loosening is to be avoided. The use of impact equations is illustrated in Fig. 4. The curves show that if loosening is to be completely avoided for moderate values of impact energy, the initial tension must not exceed a prescribed maximum value. Loosening is unavoidable at extremely high values

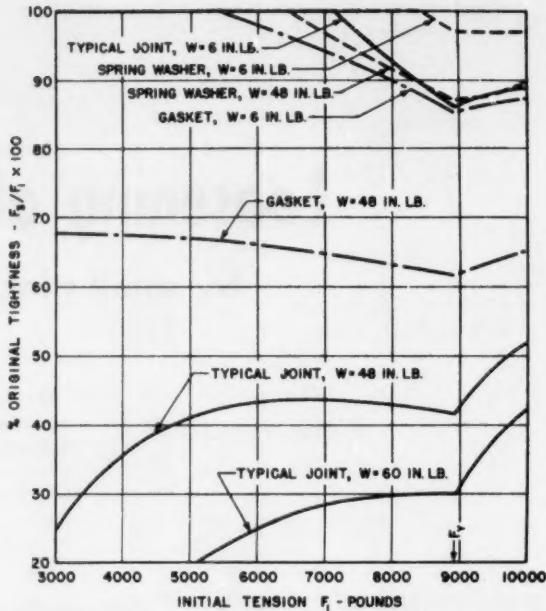


Fig. 4—Effects of initial tension, gaskets, and spring washers on loosening by one application of impact load.

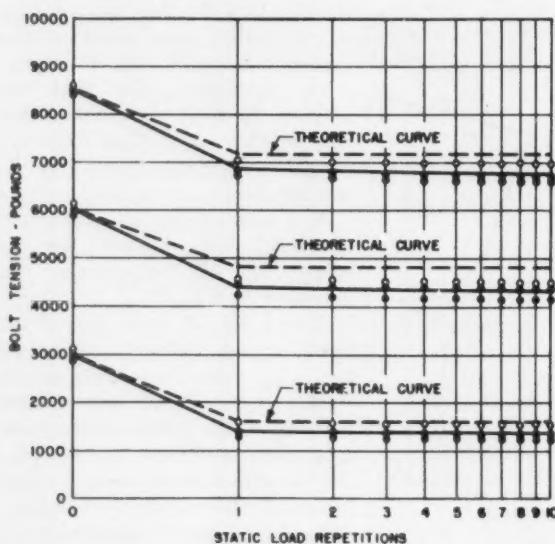


Fig. 5—Loosening caused by repetition of a large external force.

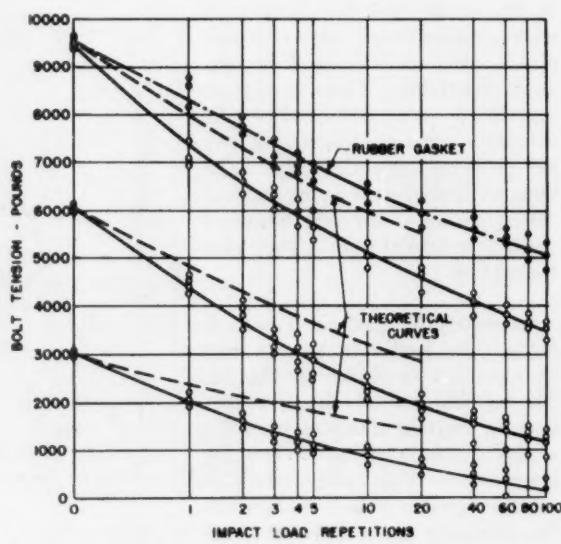


Fig. 6—Loosening caused by repeated impact with moderate pendulum energy.

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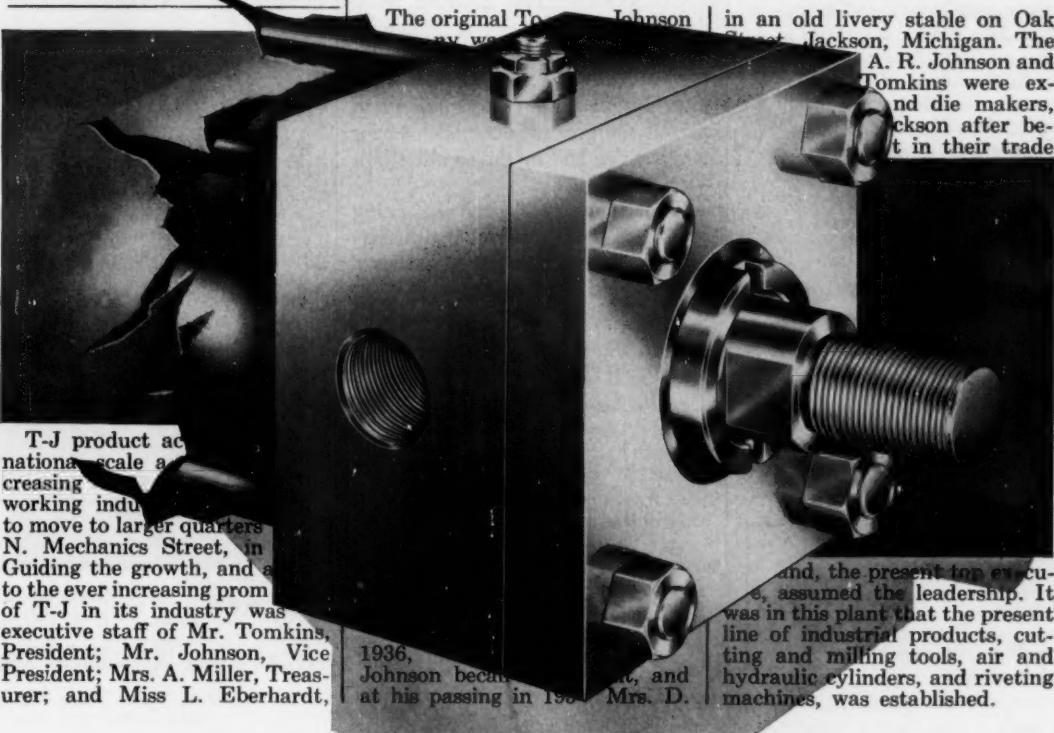
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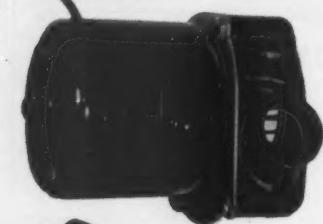


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Circle 462 on Page 19

DESIGN ABSTRACTS

of impact energy, but the amount of loosening can be decreased by tightening to higher values of initial tension.

Gaskets appear to increase loosening somewhat under moderate impact loads, and to markedly reduce loosening under extremely large impact loads.

In all instances, loosening is substantially reduced by the addition of a spring washer. The effect is particularly remarkable at high impact loads.

Representative results are shown in Fig. 5 and 6 for loosening due to repetitions of a large external force. Actual loosening was somewhat greater than that calculated. Most of this discrepancy is probably due to loosening from other causes. It was also found that an extremely small amount of loosening occurred on each successive load repetition after the first.

Loosening due to repeated impact is shown in Fig. 6. At the moderate load of 48 in.-lb, there is substantially no loosening for initial tensions of 3000 and 6000 lb. There is definite loosening for an initial tension of 9500 lb.

Conclusions: The designer must determine the amount of loosening which is admissible in a particular application. The toleration of some loosening by plastic deformation will permit the greatest external load for a given size bolt or the smallest bolt for a given load.

The amount of such loosening can then be minimized by specifying high tightening torques. Use of spring washers or, depending on conditions, addition or removal of gaskets may bring the loosening to within acceptable limits.

ASME Paper No. 60-WA-116, "Loosening of Bolted Joints by Small Plastic Deformations," presented at the Winter Annual Meeting, New York, Nov.-Dec., 1960, 8 pp.

hydraulic

Analyzing Pneumatic Circuits

Gil Riske, senior engineer, Hannifin Co., Div. of Parker-Hannifin Corp.

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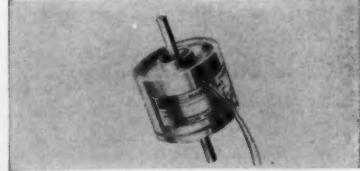
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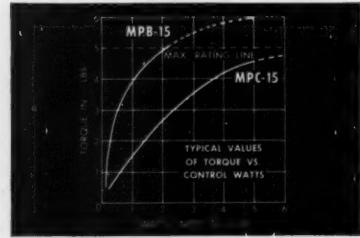
- Fast response time — better than 5 milliseconds
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- Smoothness
- No chatter



Type MPC-15 Electomic Clutch transmits high torque .90 in.-lb. per watt of input power. • Speed: 5000 RPM max. • Output Inertia: 1.85 gr. cm² • Input Inertia: 21.5 gr. cm² • Weight: 8 ounces max. • Resistance: 140 ohms $\pm 5\%$ • Dielectric Strength: 500 VDC • Life: 100,000 clutch cycles min. • Response Time: Better than 5 ms. • Environmentally tested to meet or exceed Mil-E-5272C



Type MPB-15 Electomic Brakes are designed for high braking 2.5 in.-lb. per watt of input power. • Speed: 5000 RPM max. • Total Inertia: 2.0 gr. cm² • Weight: 8 ounces max. • Resistance: 300 ohms $\pm 5\%$ • Dielectric Strength: 500 VDC • Life: 100,000 braking cycles min. • Response Time: Better than 5 ms. • Environmentally tested to meet or exceed Mil-E-5272C



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Circle 463 on Page 19

analysis of steady flow systems, and some factors affecting the degree of accuracy of the calculations. The author suggests the use of flow factors to rate pneumatic valves and other components. The flow factor of a pneumatic component may be defined as the maximum air flow rate that can be put through it for each unit value of absolute supply pressure.

The National Bureau of Standards' suggestion for determining the total flow factor of a series of components is reworked and simplified to a graphical process whereby the flow factors may be related to lengths of straight pipe or tubing of any internal diameter.

NCIH paper, "Analyzing Pneumatic Circuits—It's an Art," presented at the 16th Annual National Conference on Industrial Hydraulics, Chicago, Oct., 1960, 15 pp.

Bibliography on Diaphragms and Aneroids

Lyman M. Van der Pyl, editor, chief chemist, Rockwell Mfg. Co., Pittsburgh

Abstracts of 171 references compiled by a subcommittee of the ASME Research Committee on Mechanical Pressure Elements. This list includes many of the papers listed in the bibliography on "Diaphragms and Aneroids," (ASME Paper No. 55-A-180, by G. H. Lee and L. M. Van der Pyl), with the addition of some missing papers and some later papers.

ASME Paper No. 60-WA-122, "Bibliography on Diaphragms and Aneroids," presented at the Winter Annual Meeting, New York, Nov.-Dec., 1960, 19 pp.

bearings

Externally Pressurized Journal Gas Bearings

John H. Laub, California Institute of Technology

Investigation of externally pressurized gas-lubricated bearings with multiple orifice feed. An analytical treatment is developed for a semi-cylindrical bearing with 9 orifices and for a cylindrical journal bearing with 192 radial and 24 axial orifices.

Experiments are described on

if
all you have
for a relay
is a sudden
impulse...



An impulse relay—one that when pulsed will turn something on and leave it on and when identically pulsed again will turn the load off and leave it off—is nothing new. For years you've been able to buy them, complete with ratchets, pawls, escapements, walking beams, lock-in mechanisms, etc., in a regular commercial quality grade. Sequencing and stepping relays are the more educated relatives in the family.

But in the recent trend of getting more things up in the air, and generally getting more and more out of smaller and smaller relays for practically no power and under unpleasant conditions, the standard commercial impulse relay has often gotten dirty looks. Generally, it wouldn't hold together under the vibration or shock levels, and its size and relatively short life further complicated things.

Naturally, Sigma now has an impulse relay with none of the above drawbacks (mostly because it has none of the above mechanical mechanisms). SPDT contacts will switch 2 amp. resistive loads



(28 VDC/120 VAC) 200,000 times; mechanical life with no contact load is 4 million operations. It works on positive DC pulses as short as 1 millisecond, at speeds up to 10 pps. For the space, weight and power pinchers, this new hermetically sealed relay takes up 1" x 1" x 1 1/4", weighs about 2 1/4 ounces and transfers its contacts on as little as 250 microjoules (e.g., 250 mw. for 1 ms.). Vibration immunity is in the order of 30 g's to 2000 cycles, operating temperature -65° to +125°C. About the only caution is that you've got to feed it pulses of the same polarity.

We're building this little marvel and even have a few anxious customers. People who build telemetering equipment, satellites, and perhaps computers as well, are the Sales Dept.'s great white hope. If you like binary counting schemes and such, think of the possibilities if you hooked up several in sequence. And with a small roulette wheel and an acquisitive impulse, one might do handsomely, mightn't one?

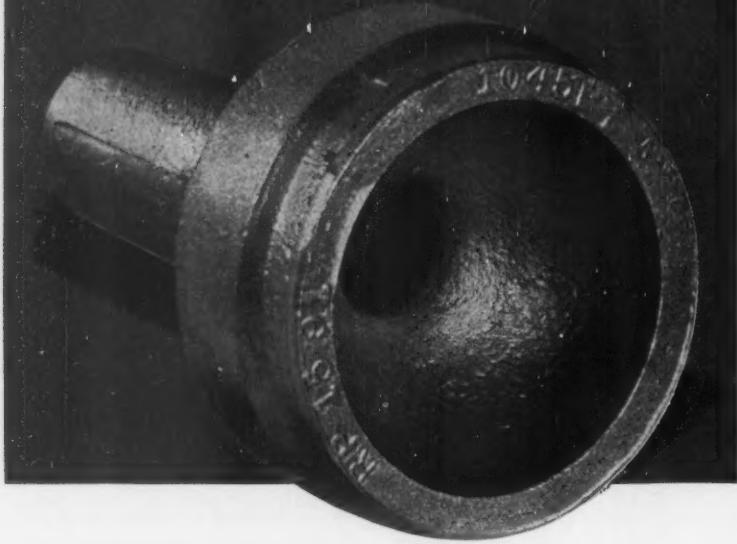
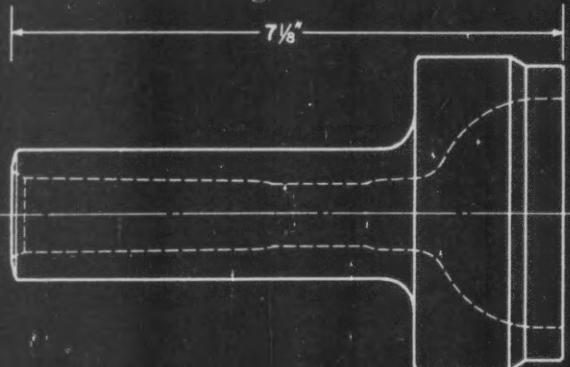
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89 Pearl Street, So. Braintree 85, Mass.

AN AFFILIATE OF THE FISHER-PIERCE CO.

PROBLEM:

Excessive drilling and machining on vital defense forging.



SOLUTION:

AmForge engineers offered a design using new upset techniques.

The head was forged closer to final tolerances, cutting down machining time. The stem was pierced, eliminating a costly drilling operation.

Slight forging cost increase was more than offset by saving in machining. Also, strength was added to the critical stem by controlling distribution of metal and grain flow during piercing.

If you have a similar problem part, consult AmForge. Write for our new brochure and the name of your nearby AmForge sales engineer.

Remember: your problems . . . our challenge!



a division of American Brake Shoe Company, 1220 West 119th Street, Chicago 43, Illinois. Two plants in Chicago, one in Azusa, California

WHEN IT'S A VITAL PART, DESIGN IT TO BE



DESIGN ABSTRACTS

models of the two bearing configurations with specially designed fixtures which incorporate pneumatic loading and means for determining pressure profiles, gas flow, and gap height. Correlation between theory and experiment is satisfactory.

ASLE Paper No. 60 LC-15, "Externally Pressurized Journal Gas Bearings," presented at the ASLE/ASME Lubrication Conference, Boston, Oct., 1960, 16 pp.

lubrication

Behavior of Lubricating Oils In Inert Gas Atmospheres

A. Beerbower and D. F. Greene, Esso Research and Engineering Co.

Interactions of five gases (helium, hydrogen, nitrogen, argon, and carbon dioxide) with mineral and synthetic lubricating oils. Interactions examined included gas solubility, foaming, entrainment, evaporation of oil into gas, stability of oil in presence of gas, and effect of dissolved gas on oil viscosity. Several of the gases showed behavior (appreciably different from that of air) that was not predicted by conventional theories. No important differences were found between mineral and synthetic (diester) oils in these respects. Additives used can have appreciable influence on the foaming and entrainment characteristics, and evaporation rates, of both types of oils.

ASLE Paper No. 60-LC-6, "The Behavior of Lubricating Oils in Inert Gas Atmospheres," presented at the ASLE/ASME Lubrication Conference, Boston, Oct., 1960, 10 pp.

techniques

Dissimilarity Laws in Centrifugal Pumps and Blowers

A. J. Stepanoff and H. A. Stahl, Ingersoll-Rand Co.

Use of affinity laws to predict the performance of a machine if tests of a geometrically similar model are available. Two kinds of dissimilarities are recognized:

1. Planned dissimilarities between the different hydraulic machines as expressed by the performance specific speed.
2. Forced dissimilarities which are re-

quired to accommodate some special condition at the same performance specific speed.

ASME Paper No. 60-W-145, "Dissimilar-Laws in Centrifugal Pumps and Blowers," presented at the Winter Annual Meeting, New York, Nov.-Dec., 1960, 10 pp.

mechanical

Stress and Deflection Calculations for U-Springs

Joseph E. Fleckenstein, staff mechanical engineer, Johnson Service Co.

Stresses and deflections in four types of U-springs, analyzed through application of Hooke's law of elastic deformation. Final equations are simplified, largely by the introduction of a parameter, to facilitate industrial applications of U-springs. Moments, stresses, slopes, and deflections at all points in the springs can be calculated readily with the treatment presented. Observations of experiments confirm the derived expressions. Merits of discriminately designed U-springs are illustrated, and brief comparisons are made to other types of energy-storing devices, such as coil springs and torsion bars.

ASME Paper No. 60-WA-172, "U-Springs—Stress and Deflection Calculations," presented at the Winter Annual Meeting, New York, Nov.-Dec., 1960, 7 pp.

TO OBTAIN COPIES of papers or articles abstracted here, write directly to:

ASLE—American Society of Lubrication Engineers, 5 North Wabash Ave., Chicago 2, Ill.; papers 50 cents to members, 75 cents to nonmembers.

ASME—American Society of Mechanical Engineers, 29 West 39th St., New York 18, N. Y., papers 50 cents to members, one dollar to nonmembers.

NCIH—National Conference on Industrial Hydraulics, sponsored by Illinois Institute of Technology, 3300 South Federal St., Chicago 16, Ill., Vol. XIV, Conference Proceedings, 6 dollars each.

Correction

The pneumatic force balance described on Page 113 of the October 27 issue was developed by Sorteberg Controls Co., South Norwalk, Conn. Fischer and Porter Co. is one of several companies that sell the balance.

ESSENTIAL TO NUMERICAL CONTROL

Maxitorq ELECTRIC CLUTCHES and BRAKES



SERIES 9000

COMPACT DESIGN • FAST RESPONSE POSITIVE REMOTE CONTROL PERFORMANCE

Incorporating advanced design principles proved through years of service, the MAXITORQ Electric Clutch is well adapted to all types of machine drives. Simple in design . . . built to machine tool standards . . . requires no adjustments, can be used either as a clutch or brake. Disc separators not only separate discs, but also break up residual magnetism and result in extremely fast, positive action with no drag or heating in neutral. There are few moving parts. Electrical operating unit remains stationary — hence, no troublesome slip rings, brushes, or difficult wiring problems. Operation is on standard 100 V a.c. Other voltages on special order.

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WIRING**

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THE CARLYLE JOHNSON MACHINE CO.
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Helpful Literature for Design Engineers

For copies of any literature listed, circle Item Number on Yellow Card—page 19

Photoelectric Control Unit

Bulletin PE-7 describes new photoelectric control unit, a combination of electronic timer and photoelectric scanner. Six systems that provide scanning ranges from 2 in. to 18 ft are described in detail. Typical applications, dimension and connections diagrams, and instructions for installation and adjustment are provided. 2 pages. Farmer Electric Products Co. Inc., 2300 Washington St., Newton Lower Falls, Mass.

Circle 601 on Page 19

Industrial Pumps

Bulletin One describes an entire line of liquid material-handling equipment. Catalog pictures and describes power-driven pumps, variable-capacity pumps, proportioning systems, strainers, hand pumps, truck pumps, aluminum transporter pumps, and liquefied gas pumps. It also includes a preliminary selection guide for power pumps. Cut-away photographs of pump models, and component-part drawings show the outstanding features of the units. 8 pages. Blackmer Pump Co., 1809 Century S.W., Grand Rapids, Mich.

Circle 602 on Page 19

Reset Timer

New illustrated folder gives detailed information on Acrotimer, an external-clutch reset timer. Folder shows the basic unit and accessory elements, along with a reference chart of 12 standard variations available. Ratings of the unit and accessory elements are clearly stated, and design and construction features are pointed out. Folder also shows blueprint dimensions of both the rear and panel-mounted series, as well as diagrams of six common circuit arrangements. 4 pages. Hayden Div., General Time Corp., 245 E. Elm St., Torrington, Conn.

Circle 603 on Page 19

Flow Indicators, Alarms

Bulletin 132 describes flow-rate measurement meters designed to operate at pressures to 1500 psig. Units are pictured, and dimensional data are given. Chart of flow ranges is provided. Large line drawing is used to point out design features of the units. 2 pages. Brooks Instrument Co. Inc., Hatfield, Pa.

Circle 604 on Page 19

Voltage Regulators

More than 2000 voltage-regulator models are described in Catalog 4-265. Providing complete specification data for all

standard magnetic voltage-regulator models, catalog also offers information on selection and use of regulators in dc power-supply design. Convenient selection of desired electrical and physical characteristics from the new line are shown in large, fold-out chart. 10 pages. Power Supply & Voltage Regulator Operations, Raytheon Co., Keeler Avenue, South Norwalk, Conn.

Circle 605 on Page 19

Air Compressors

Illustrated Bulletin 203 introduces C-Line packaged air compressors for industrial applications. Fully described and illustrated are all important features. Longitudinal and transverse cross-sections with call-outs highlight important construction features. Brochure includes a complete list of dimensions, weights, and specifications for the units, furnished with or without drive. 6 pages. Clark Bros. Co., Div., Dresser Industries Inc., Olean, N. Y.

Circle 606 on Page 19

Motor Pump

Useful information on a new, quiet-running motor pump is presented in Form 70287. Booklet describes 1750K pump, designed with a 1750-rpm operating speed. It also tabulates operating data on all models. Figures are given for rated head and capacity of pumps equipped with $\frac{1}{4}$ to $7\frac{1}{2}$ -hp motors. Physical dimensions and mounting versatility data are provided in tables and drawings. 4 pages. Ingersoll-Rand Co., 11 Broadway, New York 4, N. Y.

Circle 607 on Page 19

Bronze Bearings

Stock List Brochure S-60 details 1066 standard, self-lubricating, bronze bearing sizes. Included are Oilite bronze in cored, bar, plate stock, discs, and strips, and Super Oilite in cored and bar stock. Special section is devoted to engineering data with pictured demonstrations of the self-lubricating qualities of the bearings. 18 pages. Amplex Div., Chrysler Corp., Box 2718, Detroit 31, Mich.

Circle 608 on Page 19

Wire Products

Brochure DM-S-6014 contains condensed data on complete line of electronic hook-up wire. Booklet supplies specifications for a line of wire products with various insulations for a wide range of temperature and environmental conditions. Also featured are Tri-Tin conductors and Hy-shrink tubing and sleeving. Additional technical data consist of tables covering decimal equivalents, temperature conver-

sions, and AWG data for standard annealed copper wire. 12 pages. Dept. EFL, Anaconda Wire & Cable Co., 25 Broadway, New York 4, N. Y.

Circle 609 on Page 19

Molding Compound

Product Bulletin GS-2 provides data on Nylatron GS, a molding compound of nylon and molybdenum disulfide. Bulletin features a roundup of 45 new application case histories, as well as latest physical property data. Product advantages for both industrial designers and injection molders are included. 4 pages. Molding Resins Div., Polymer Corp., 2120 Fairmont Ave., Reading, Pa.

Circle 610 on Page 19

Variable Inductor Coils

New catalog contains charts and data information which graphically illustrate electrical parameters under various conditions for variable inductor coils. Charts can be employed to predict electrical parameters if form size, wire size, and winding construction are varied from the set conditions used in preparation of the curves shown. Depending upon the coil-design knowledge of the user, charts can be quite accurate for predicting results of design changes. 20 pages. Delavan Electronics Corp., 77 Olean Rd., East Aurora, N. Y.

Circle 611 on Page 19

Nylon Threaded Fasteners

New standard specifications cover six head types available for nylon machine screws and six point types available for nylon headless set screws. Sheet gives complete details on threads and principal dimensions for all head types. 1 page. Gries Reproducer Corp., 400 Beechwood Ave., New Rochelle, N. Y.

Circle 612 on Page 19

Motor Selection Guide

Bulletin 1024 is designed to assist in the selection of suitable motors from $\frac{1}{2}$ to 10,000 hp for specific installation on original equipment, in commercial buildings, and industrial installations. Outlined are ac induction motors, either low or high slip, for normal or troublesome loads. A number of mechanical variations are shown. Also included is a section on constant speed, unity power factor, synchronous motors in horizontal or vertical construction. 12 pages. Electrical Div., Fairbanks, Morse & Co., 303 N. Henderson, Freeport, Ill.

Circle 613 on Page 19



Tracking a Surveillance Drone with the Visicorder

Drone surveillance and reconnaissance gives U.S. Army combat units a high-altitude vantage point with much broader horizons from which to view battlefield action and terrain.

If effective use of the data gathered by the drone—the “eye in the sky”—is to be made, accurate instruments have to be on hand to monitor the drone's position and movement, its operational behavior and its response to flight commands. Telemetry supplies the radio link which transmits all this behavior information to a thoroughly-instrumented mobile tactical command post developed by Tele-Dynamics Division of American Bosch Arma Corp.

The Honeywell Model 1012 Visicorder has been selected as the direct readout unit in the Tele-Dynamics Drone Surveillance Telemetry system. In use with its companion instrumentation, the 36-channel Visicorder simultaneously displays the 22 channels of information required to track a drone, plus the timing traces.

In the Tele-Dynamics van, which serves as a tactical command post, the Visicorder provides both an instant “quick look” and a permanent record of the drone's operational parameters.

Signals are transmitted over a single channel by time-multiplexing. Signal and battery strength, engine speed and temperature, pitch and roll commands, altitude, air-speed, attitude (pitch and roll), yaw, acceleration (horizontal and vertical), and angle of attack are recorded by the Visicorder, along with three separate records of vibration.

Like the other units of the Tele-Dynamics system, these Honeywell Visicorders are built for rugged service . . . to deliver the data . . . when the drone is up and the chips are down.

Call your nearest Minneapolis-Honeywell Industrial Sales Office for a demonstration of how a Visicorder Oscillograph will save you time and money in data acquisition. OEM inquiries invited.

Reference Data: write for bulletins 906, 1012, 1108 and 1406.

*Minneapolis-Honeywell Regulator Co.
Industrial Products Group, Heiland Division
5200 E. Evans Avenue, Denver 22, Colorado*

Honeywell



Industrial Products Group

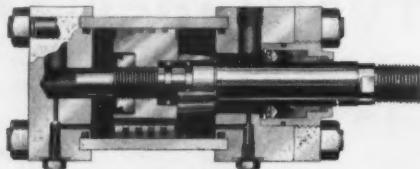
HONEYWELL INTERNATIONAL Sales and Service offices in all principal cities of the world.

EXCLUSIVE WITH CARTER!

ROD SCRAPER PLUS

ROD WIPER AS STANDARD

J. I. C. Interchangeable **SQUARELINE** Series features a Metal Rod Scraper plus a Rod Wiper in a quick change Cartridge—*Double protection* against chips, dirt, damage. Unitized cartridge rod bearing... easy removal and replacement... no cylinder disassembly necessary!



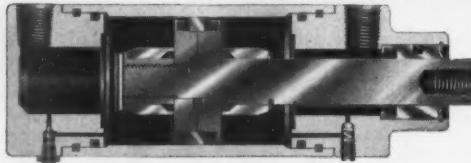
SQUARELINE 2000-3000 PSI HYDRAULIC

- 1½" to 12" bore
- True cushion-automatic concentric alignment
- 100% JIC interchangeable
- Positive piston locknut design
- Delivery from stock!

THE COMPLETE LINE

CARTER FLUID POWER

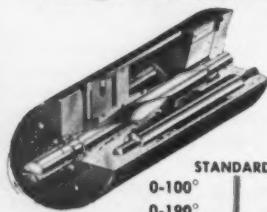
ROUNDLINE AIR-HYDRAULIC



- Space saving designs! Light weight!
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- Precision honed heavy wall tubing—6 to 1 safety factor.
- Spring loaded "V" packing on rod end gland.
- Key type stainless steel locking ring. Allows 360° orientation of pipe ports.

ROTARY TORQUE ACTUATOR

PNEUMATIC-HYDRAULIC



STANDARD ROTATIONS

0-100°	0-280°
0-190°	0-370°

- New design opportunities
- To 370° rotation as standard
- Safe, powerful torque
- Air, oil, gas, water operation
- Zero leakage

IMMEDIATE DELIVERY ON ALL STANDARD CYLINDERS AND ACTUATORS

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Complete bound file. Air and hydraulic cylinders, Rotaries, clamp cylinders, air valves, and the new **SQUARELINE**. Complete details and prices. **SEND TODAY.**



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HELPFUL LITERATURE

Fractional-Horsepower Motors

New folder details dimensions, ratings, and other application information on complete line of fractional-horsepower ac motors. Folder uses photographs, specification charts, and engineering drawings to show design and performance details of the shaded-pole and permanent split-capacitor units. All factors of motor speed, power requirements, and dimensions are illustrated for each of the four types of motors shown. 4 pages. Leece-Neville Co., 989 Athens St., Gainesville, Ga.

Circle 614 on Page 19

Force Transducer

Illustrated design and application brochure gives complete data on new force transducer, an accurate, fast-response, mechanical-to-electrical primary element for continuous measurement and control of varying amplitude forces. Section with cross-sectional drawings gives complete design details of the unit, and illustrations show special design features. Complete specifications for standard units are given. 4 pages. Force Transducer Sales Div., Hydro-Pneu-Tronics Inc., 3666 E. 116th St., Cleveland 5, Ohio.

Circle 615 on Page 19

Liquid-Level Sensors

Utilized liquid-level switches which combine an ultrasonic probe and a transistorized control into an integral unit are described in new folder. In addition to providing specifications, folder relates how the sensors, either as integral or separate units, monitor a large number of liquids, including cryogenics, chemicals, and petroleum products. 4 pages. Gauge & Control Marketing Dept., Acoustica Associates Inc., 10400 Aviation Blvd., Los Angeles 45, Calif.

Circle 616 on Page 19

Control Pilot Devices

Bulletin GEA-7302 describes line of control pilot devices which includes pressure and vacuum switches, pressure governor, plugging and antiplugging switches, float switches, pilot switches, and manual-reversing switches. Advantages of each product are listed, along with rating and nomenclature charts. Photographs and diagrams depict each of the devices, and optional accessories are listed. 8 pages. General Electric Co., Schenectady 5, N. Y.

Circle 617 on Page 19

Timing-Belt Drives

Information needed to select the proper timing-belt drive with minimum arithmetic is available in Catalog 19103. Catalog features a series of charts which provide graphical solutions in place of numerical calculations. One chart provides graphic selection of the proper pitch from the factors of design horsepower and speed of pulley of largest rpm. Drive-width selection charts and drive tables are included. 80 pages. T. B. Wood's Sons Co., Chambersburg, Pa.

Circle 618 on Page 19

Silicon-Power Rectifiers

Series of technical data bulletins deals with three silicon-power rectifiers in Series 1N. Bulletins cover specifications, ordering references, and performance characteristics on 20, 35, and 70-amp units. Bulletins are numbered 6.304-1, 6.305-2, and 6.307. 8 pages total. Rectifier-Capacitor Div., Fansteel Metallurgical Corp., North Chicago, Ill.

Circle 619 on Page 19

Miniature Plugs

Catalog KQ/KR-1 presents a comprehensive description of new line of miniature plugs, designed to meet severe requirements of aircraft and missile applications. Line drawings and tables are used to present the specifications of the various units in the line. Explanation of nomenclature is also provided. Information on insertion and extraction tools is included. 12 pages. Cannon Electric Co., 3208 Humboldt St., Los Angeles 31, Calif.

Circle 620 on Page 19

Bolts and Screws

New engineering data bulletin contains design characteristics of Long-Lok self-locking bolts and screws, a table of torque testing per MIL-F-18240 specifications, and temperature and strength data. Shown also are physical test data and typical applications. 4 pages. Long-Lok Corp., 2601 Colorado Ave., Santa Monica, Calif.

Circle 621 on Page 19

Reproduction Materials

Applications and specifications for a broad range of diazotype reproduction materials are condensed for easy reference in new selector chart. Printed on heavy stock, the 11 x 17-in. chart lists uses, base materials, image colors, printing speeds, stocks, trade names, price ranges, sheet and roll sizes, and eradicators. Simplified description of basic diazotype positive copy process is included. Frederick Post Co., 3650 N. Avondale Ave., Chicago 18, Ill.

Circle 622 on Page 19

Fine Wire

New bulletin contains data on fine wire for semiconductors, resistors, potentiometers, thermocouples, electronic tubes, and other electronic applications. Chart on fine-wire applications, compositions, and pertinent properties is included. 4 pages. Consolidated Reactive Metals Inc., 115 Hoyt Ave., Mamaroneck, N. Y.

Circle 623 on Page 19

High-Heat Paint

Form 1206 describes Heat-Rem H-120A aluminum high-heat paint which resists temperatures to 1200 F. Complete data on applications, methods of application, coverage, resistance, and other features are provided. 3 pages. Speco Inc., 7308 Associate Ave., Cleveland 9, Ohio.

Circle 624 on Page 19



Why "MARK-TIME" MECHANICAL TIMERS should be INVESTIGATED!

Low cost mechanical Timers, Time Switches and Time Devices can be quite sophisticated. For example: they can be designed to ring bells, flash lights, turn valves, cut cords, start, stop or operate electrical or mechanical equipment, and to do all this after a pre-selected time period has elapsed.

The "Mark-Time" mechanical "memory" cannot fail due to an electrical failure since it is spring powered.

The "HEART" of the "Mark-Time" is of a new super-tough alloy which prolongs mainspring life indefinitely.

This new special steel virtually eliminates mainspring failure. This adds extra sales features to your product at no extra cost.

The "MARK-TIME" Mainspring is Unbreakable!

Tensile strength, durability and corrosive resistance is unexcelled. No other Timer on the market has these exclusive features.

At present, we manufacture more than 3,000 DIFFERENT kinds of custom-built timers for industrial, consumer and military applications. Thus, we are the largest manufacturer of mechanical timers in the world!

Research and development work welcome—small runs our specialty.

Sales engineers in 27 key cities at your service.

Write for your copy of this new Engineering Handbook on Timers, specifically written and illustrated for the Design and Development Engineer.



M. H. RHODES, inc.

HARTFORD, CONNECTICUT

Circle 469 on Page 19

**Tomorrow's Electric Motors
are available today . . .**

COMPUTER

DESIGNED and PROVED

**BEST POWER FOR THE STANDARD OR
THE UNUSUAL MOTOR APPLICATION . . .**



Modern as the missile age . . . Imperial electric motors are created with a background of more than 70 years of industrial drive experience.

Now, through the use of electronic computers, multiple-design review is made possible in advance of production. Optimum performance is assured while delivery of special-purpose designs is speeded.

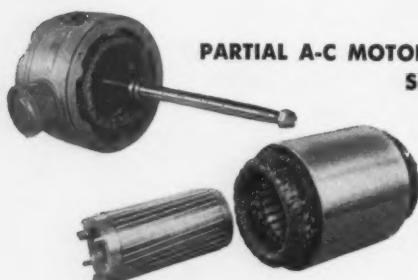
For standard NEMA motors and for motors to meet unusual drive requirements, you will do better with Imperial. Write for bulletin covering *The Imperial Line* of integral horsepower motors, generators and motor-generator sets for every application.



DRIP-PROOF A-C MOTOR—Today's Best Buy for Most Applications—Ratings from 1 to 200 Hp.—Designs Include Flange and Face Types, Multi-Speed, etc.



TOTALLY-ENCLOSED, FAN-COOLED A-C MOTOR Provides Dependable Operation Under Abnormal Conditions—Also Available in Explosion-Proof Design—1 to 100 Hp.



PARTIAL A-C MOTOR . . .

SHELL-TYPE SHAFTLESS MOTOR . . . Other Special or Specific Types . . . Provide Maximum Power in Minimum Space . . . Blend with Basic Design of Machines.



ELECTRIC COMPANY

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HELPFUL LITERATURE

Ball Valve

Bulletin DH-38 describes new forged naval bronze ball valve. In addition to stating the features of the valve, folder includes a cross-section illustrating construction of valve keyed to a material and dimensions specification table. Dimensional drawing and tables are incorporated. 4 pages. R-P&C Valve Div., American Chain & Cable Co. Inc., Reading, Pa.

Circle 625 on Page 19

Panel Fastener

Self-aligning, self-locking, P-Series panel fastener for use in a wide variety of removable-panel applications is described in new brochure. Material on features and applications, dimensional and material specifications, test data, and installation methods is included through use of photographs, charts, tables, and line drawings. 6 pages. Hi-Shear Corp., 2600 W. 247th St., Torrance, Calif.

Circle 626 on Page 19

Adhesive-Bonding Films

New fold-out catalog provides actual samples of more than 40 adhesive-bonding films, together with a quick method of selecting the proper film for hundreds of bonds. Descriptions of uses for which the various adhesives are available are provided, and list of adhesive definitions is included. Girder Process Inc., 102 Hobart St., Hackensack, N. J.

Circle 627 on Page 19

Miniature Bearings

New brochure describes Inch Series of Class ABEC-7 instrument ball bearings. Major features of the units are pointed up. Specifications are presented, using tables and line drawings, and information on materials is included. 4 pages. Reed Instrument Bearing Co., Div., SKF Industries Inc., Front Street & Erie Avenue, Philadelphia 32, Pa.

Circle 628 on Page 19

Instrument Tubes

Bulletin PA-391 describes characteristics and uses for instrument tubes manufactured specifically for instrument manufacturers. It also gives information on frame grid tubes and secondary emission tubes which are a part of the new line. Pictures, tables, and charts are used to provide necessary data. 8 pages. Write on company letterhead to Technical Information Services, CBS Electronics, 100 Endicott St., Danvers, Mass.

Pump Selector

Compact, pocket-sized, Econobloc and Econopel pump selector, G2903, includes a friction-loss estimator on its reverse side. Estimator provides for accurate calculation of the friction loss in a system, which must be considered to determine the total required head. Selector is designed for fast, accurate pump selection. Write on company letterhead to Standard Products Account, Worthington Corp., Harrison, N. J.



THIS . . . IS WHAT YOU BUY!

POWER — clean, dry, drip-free power at the business end of a Hannifin piston rod is the result of Hannifin extra quality, and at no extra cost. Bores are honed to 15 RMS or finer . . . piston rods are case hardened, plated and polished to 10 RMS or better. Cartridge gland, removable without dismantling cylinder, has exclusive Hannifin-developed "Lipseal®-Wiperseal" combination for a truly drip-free rod.

Modern straight thread leak-proof ports for easily positioned fittings are available at no extra cost on hydraulic cylinders.

HYDRAULIC CYLINDERS

Two Pressure Ratings

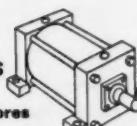
2000 psi (3000 psi non shock), the famous heavy duty Hannifin Series "H" in 1½" to 12" bore.
1000 psi, Series "L", 1" to 8" bore, Hannifin quality in a lighter cylinder. Full compliance JIC Hydraulic Specs.



AIR CYLINDERS

1½" to 14" Bores

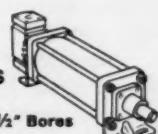
Series "A"—steel heads, honed brass body for corrosion resistance. Hardened and hard chrome plated piston rod. For all heavy duty air service. Easily modified for water service. Full compliance JIC Pneumatic Specs.



AIR MOTORS

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New from Hannifin, a complete power package combining cylinder and solenoid valve. Only one air line connection. Four mounting styles. Interchangeable mounting dimensions for most applications.



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PNEUMATIC AND HYDRAULIC SYSTEM COMPONENTS

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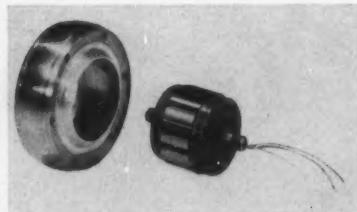
New Parts and Materials

Use Yellow Card, page 19, to obtain more information

Miniature Filter Assembly

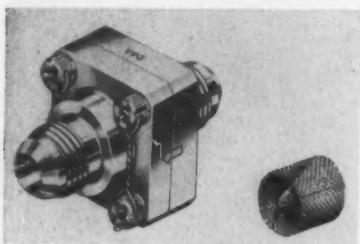
for temperatures from
-350 to +500 F

Lightweight, miniature filter assembly for fluid-line systems offers universal, in-line applications wherever caustic and/or corrosive liquids or gases are handled. It is satisfactory for use with nearly all elements and blends, including food products. It can be used with



or three-phase, 400-cycle power; with an external capacitor it operates on single-phase power. It accelerates a 480 gm-cm² inertia ring in 50 sec, and operates at 23,000 rpm with 6 w power. Excluding inertia ring, dimensions are 1 1/4 in. OD x 3/4 in. long. Curvin Development Co., 13740 Saticoy St., Van Nuys, Calif.

Circle 629 on Page 19



gases to pressures of 2250 psi, and withstands temperatures from -350 to +500 F. Unit is 1 1/8 in. square and approximately 2 in. long. It is all stainless steel, except for an enclosed, chemically inert, Teflon washer which seals the two halves of the body together. Filter element is a woven, wire-mesh screen, designed as a cylindrically shaped cup with a coned bottom. Design offers maximum flow and provides 1.2 sq in. of filter surface, of which approximately one-half is open-flow area. Assembly is available in standard sizes to fit 1/4 and 3/8-in. tube sizes. Dumont Engineering Corp., 1401 Freeman Ave., Long Beach, Calif.

Circle 629 on Page 19

Small Motor

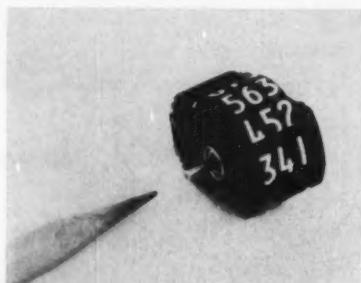
operates at 23,000 rpm
with 6 w power

Gyro Spin motor features epoxy-encapsulated stator and external rotor with cast-aluminum squirrel cage. Model 108 operates on two

Precision Counters

have 0.220-in. high figure
in 0.305-in. opening

Improved readability for below eye-level instruments is provided in Series 1736 precision counters. Maximum figure representation results from removal of transfer pinions from an exterior location to within the unit, allowing use of larger number wheels. Units have a 0.220-in. high figure in a 0.305-in. opening. Internal-pinion units have a static torque of 1 oz-in. over a temperature range of -55 to +100 C. Three or four wheels of figures are available, as well as plate extensions with stationary



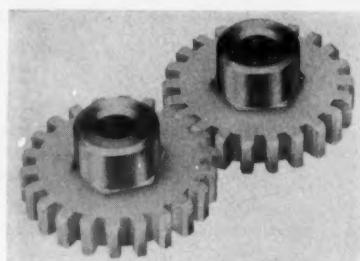
zeros and decimal-point indication. Counters can also be furnished with left-wheel stops. Frame and caps are black anodized aluminum, with drive of stainless steel. Drive shaft runs in miniature precision ball bearings, and is furnished as a left or right extension. Actual counting is performed by 0-9 unit wheels which register ten counts per revolution. Speed is 750 rpm intermittent and 300 rpm continuous. Veeder-Root Inc., 70 Sargent St., Hartford 2, Conn.

Circle 631 on Page 19

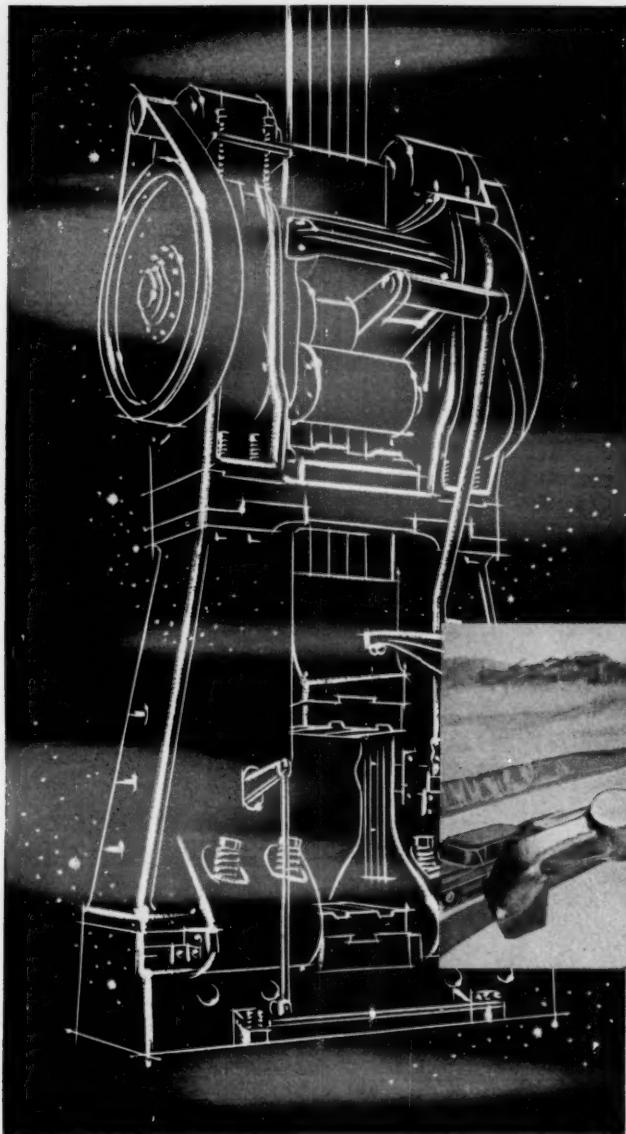
Cut Nylon Gears

incorporate hexagonal
metal hub

Nymet line of precision nylon-cut gears with molded-metal insert hubs offers cut tooth gears to 3 in. OD with up to 1/2-in. face in any

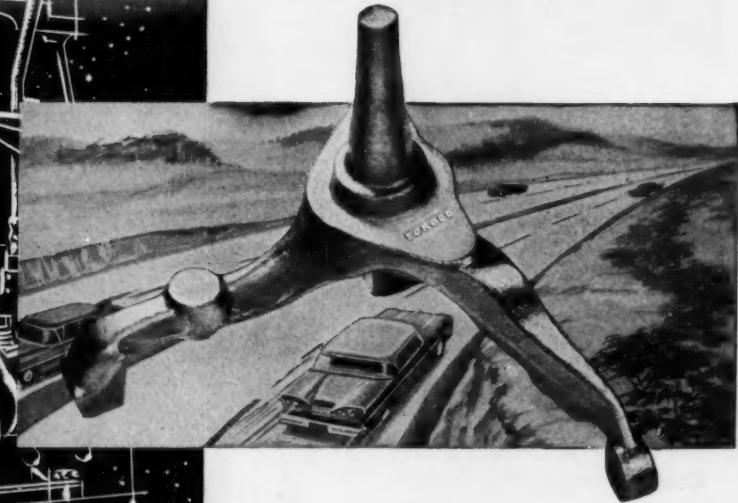


quantity without tool charge. Gears are available in 48, 32, 24, 20, 16, and 12 pitch, and in 14 1/2 and 20-deg pressure angles. Resiliency of nylon employed in the gears distributes any overload over more than one tooth, minimizing wear and failure. Hexlok hexagonal metal hub is inserted when the gear blanks are molded. It is locked radially by means of its hex shape and axially by means of a channel cut around the hexagonal face. Design offers maximum resistance to shock, torsion, and vibration. Gears



Modern board-lift forging hammer

SHOCK-STRENGTH of steering spindle soars by designing it to be forged



By designing front-end spindles to be forged, automobile and truck manufacturers practically eliminate danger of failure of these vital parts, even under sudden turning stress that can reach thousands of foot-pounds.

Start your designs by planning to use forgings everywhere there's a high degree of stress, vibration, shock, or wear. Forged parts withstand them all better than parts made by other fabrication methods. And forgings have no hidden voids to be uncovered after costly machining hours have been invested . . . the hammer blows or high pressures of the forging process compact the *better* forging metal, make it *even better*.

Write for literature on the design, specification, and procurement of forgings.

When it's a vital part, design it to be

FORGED

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For instance, Crane Packing Company's new Teflon products plant was especially designed to obtain the highest quality fabrication of this material and includes the very latest in extruding, molding, curing and machining equipment. Result: *parts and components that retain all of Teflon's outstanding electrical, mechanical, anti-corrosive, heat-resistant and other properties.*

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your requirements.
Request Bulletin T-110.



CRANE PACKING COMPANY

6425 Oakton Street, Morton Grove, Illinois

(Chicago Suburb)

In Canada: Crane Packing Co., Ltd., Hamilton, Ont.
Circle 473 on Page 19

NEW PARTS AND MATERIALS

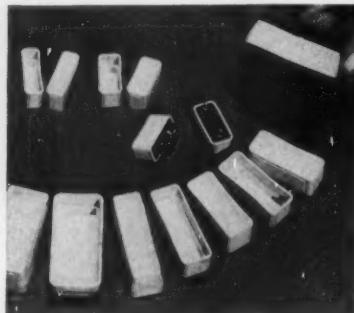
are cut with hub molded in the blank, providing superior concentricity of teeth and shaft. Inserts are of the extended-hub design; they are provided plain or drilled and tapped with socket-head set screws. Hubs are available in steel, stainless steel, brass, and aluminum alloy. Climax Metal Products Co., 863 E. 140th St., Cleveland 10, Ohio.

Circle 632 on Page 19

Plastic Protectors

for miniature, rectangular electronic connectors

Close-fitting rectangular vinyl caps provide effective, all-around protection for miniature electronic connectors during manufacture, shipment, storage, and while in service. In addition to protecting connectors from impact damage, caps keep out moisture, dust, and con-



tamination. High dielectric strength of vinyl assures insulation against shorting out and the possibility of electrical shock. Protectors are bright yellow, conforming to military specifications. Twelve sizes fit specifications for rectangular connectors (MIL C-8384). Caps are easily and quickly removed by hand, and are nonshredding. Plastic Dept., S. S. White Industrial Div., 10 E. 40th St., New York 16, N. Y.

Circle 633 on Page 19

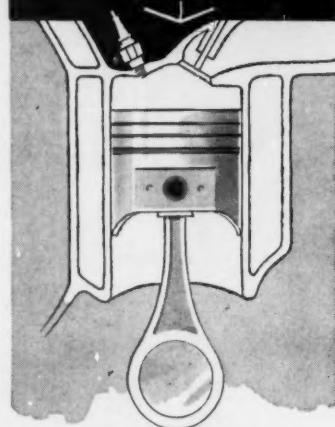
Cadmium-Sulfide Photocell

has high dark resistance

CDS-9 cadmium-sulfide photocell consists of a cadmium-sulfide layer vacuum deposited over gold, comb-like electrodes permanently bonded to a hard-glass disc measuring 0.750 in. in diam. With hermet-

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KNOW YOUR PISTONS

Do you know that a set of Gillett & Eaton Oil Absorbing Vanasil pistons ran more than 2500 hours in a heavy duty tractor *without any increase of blow-by?* This is a 40% increase in life over standard pistons.

In addition to Oil Absorbing Vanasil pistons, G & E makes tested and proven Aluminum Alloy, Hi-Tensile Iron, Bi-Metal and Insert Types in all sizes. Write for information on the performance you can expect from each type.



GILLETT & EATON, Inc.

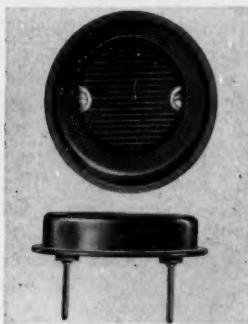
860 Doughty Street, Lake City, Minn.

Sold in Canada by
Gould National Batteries of Canada, Ltd.
Fort Erie, Ontario

Piston and casting specialists

Established 1868

Circle 474 on Page 19



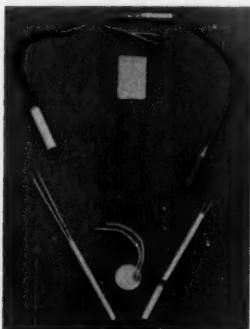
ically sealed case, unit has approximately $1\frac{1}{4}$ in. over-all diam. Variations in light intensity reaching the sensitive layer cause a changing resistance, altering the current flow and permitting the cell to act as a light-activated switch. Unit has a resistance of over 1 megohm in darkness and has a broad response to visible light. At illumination levels of 1-50 ft-c, photocell permits direct control of a relay requiring as much as 10 ma for operation. Unit is nonpolar and can be used on ac or dc. Power dissipation rating is $\frac{1}{2}$ w continuous, 2 w for 1 min. Maximum voltage is 500 v dc, or 350 v ac (rms). Pioneer Electric & Research Corp., 743 Circle Ave., Forest Park, Ill.

Circle 634 on Page 19

Ceramic Heaters

in a wide range of lengths, diameters, and voltage ratings

Expanded line of ceramic heaters is available for spot-heat applications which require a cartridge-type unit without the watt density or ruggedness of standard cartridge heaters. Applications include certain types of appliances, small tools, vending machines, embossing machines, and instruments. Construc-



HOW IS IT FASTENED? WITH RIVNUTS!



Fine metal furniture made by Chromcraft Corporation, St. Louis, Missouri, is fastened quickly and rigidly with RIVNUTS. In making a quality product, Chromcraft feels it is essential to use heavy gage tubing, joined with concealed fasteners such as RIVNUTS. In addition to improving product quality, the use of RIVNUTS reduces assembly costs... streamlines design, purchasing, and handling operations for this manufacturer. If you'd like recommendations on improving your fastening, please send a print of your part. Write for new data booklet which describes principle, typical applications of RIVNUTS, lists size and tool data. For free copy write *Dept. MD-2 B.F. Goodrich Aviation Products, a division of The B.F. Goodrich Company, Akron, Ohio.*

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RIVNUTS

3 WAYS TO PERMANENT THREADS - IN ANY MATERIAL!

For original design — production salvage
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Heli-Coil® Stainless Steel Wire Screw Thread Inserts.



HELI-COIL Standard Insert for stronger, smoother, lifetime threads

Permanently protects threads against wear, stripping, corrosion, galling, seizing, vibration, and shock. Made of 18-8 stainless steel wire, this precision-formed *Heli-Coil* Insert has a tensile strength of approximately 200,000 psi. Conforms to military standards and all commercial and industrial thread forms.



HELI-COIL Screw-Lock Insert eliminates lock wiring and lock nuts

This one-piece wire Screw-Lock Insert provides all the thread protection of the Screw-Thread Insert, PLUS an exclusive resilient *internal* locking feature that eliminates clumsy protruding lock nuts, lock wiring and other supplementary locking devices. It saves cost, space and weight — permits simple streamlined design in standard bosses. Meets military and N.A.S. specifications for locking torque and vibration.



HELI-COIL Shop-pack for all "on-the-job" thread repairs

Contains everything needed for fast, easy thread repair — *on the spot!* Salvage expensive parts — for pennies! Shop Pack restores threads to original size. Available in U.N.F. and U.N.C. sizes 6-32 to 1½-6. There's a kit for spark plug and pipe thread sizes, too. Each Shop Pack contains a supply of *Heli-Coil* Screw-Thread Inserts with special tap plus inserting tool.



There is a *complete* line of *Heli-Coil* products for every thread need: inserts, taps, tools and gages. Let us help with your design and application problems. Write today for complete information.



HELI-COIL CORPORATION

502 Shelter Rock Lane, Danbury, Connecticut

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NEW PARTS AND MATERIALS

tion of the core, including coils and terminals, is similar to that of standard cartridge units. It is packed with magnesium oxide and cemented with porcelain cement. Lead lengths and types are optional; wide range of diameters, lengths, wattage, and voltage ratings is available. Vulcan Electric Co., 88 Holten St., Danvers, Mass.

Circle 635 on Page 19

Recentering Mechanism

in sleeve or
ball-bearing design

Series 1300 mechanism is designed principally for returning to center the shaft of components such as syncros, potentiometers, encoders, commutator switches, and gear trains. Mechanism is available in sleeve or ball-bearing design, with



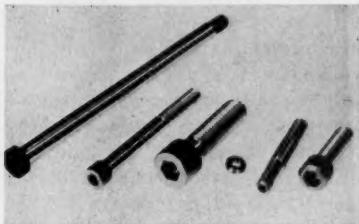
standard servo mounts or mountings designed for inclusion in the original design of components. Units are available with adjustable stops to 320 deg rotation, and meet MIL specifications. MagneTec Corp., 7232 Eton Ave., Canoga Park, Calif.

Circle 636 on Page 19

Internal Wrenching Bolts

have minimum 130,000 psi
tensile strengths

Internal wrenching bolts are available for high-temperature applications to 1800 F. Bolts are furnished in popular thread sizes and lengths, and are made in high-temperature material AMS 5735 with minimum tensile strengths of 130,000 psi. Heads accept standard Allen-type wrenches, and can be supplied with drilled holes for lock-wire installations when required.



Fasteners are also available in such materials as 19-9DL, Inconel X, M-252, Titanium, and other heat-resistant alloys. Mercury Air Parts Co. Inc., 9310 W. Jefferson Blvd., Culver City, Calif.

Circle 637 on Page 19

Molding Compound

has excellent electrical resistance

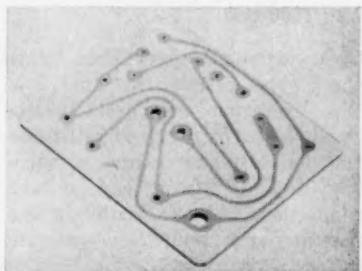
Copy-Cast two-part molding, bonding, filling, and shape-making compound resists acids, alkalis, grease, and solvents. Nonshrinking and noncrumbling, it holds its shape and can be worked and finished with ordinary tools. Compound has excellent electrical resistance, and adheres to most surfaces. Future Chemicals Mfg. Co., 4350 N. Whipple St., Chicago 18, Ill.

Circle 638 on Page 19

Printed Circuit

of glass-bonded mica

Nonwarping, high-reliability printed circuit utilizes Mykroy glass-bonded mica with deposited copper. Applications include circuits for ferrite memory systems, radar circuitry, substrate amplifier systems, missile-control circuitry, and switching commutators. Glass-bonded mica is a dense, rock-like material resulting from the fusion of molten electrical glass and mica. Electrical and mechanical properties make material superior for use



February 2, 1961

**"Who's best for
ON TIME
deliveries
of short
run
stampings?"**



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Freddy Federal says: "Fast production and on-time stamping deliveries are our specialty. Every job is speedily handled, whether a limited prototype . . . a small pilot run . . . or 10,000 or more pieces. You receive all the benefits of streamlined tooling and work flow methods in our modern one-stop plants . . . plus skilled and experienced craftsmen who are personally interested in meeting your stamping requirements. Send us your part or print today for a prompt, money-saving quotation. Time real short? Just ask for a reply by wire or phone! It's another Federal service to give you stamping deliveries on time!"

Write for illustrated Catalog No. 301 with its many stamping design tips!

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No. Hollywood, California

Circle 477 on Page 19

153



Payloader H-70—photo courtesy The Frank G. Hough Co.

R/M sintered friction development use-proven in over 6000 Payloaders

The Hough-built "PAYLOMATIC" P-600 full power-shift transmission utilizes a wet-friction application jointly developed by The Frank G. Hough Co., Libertyville, Ill., and Raybestos-Manhattan.

No friction failures

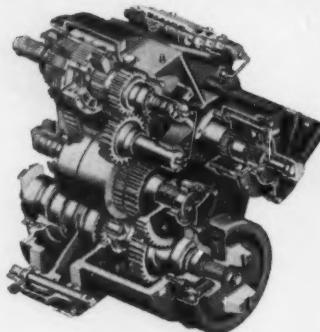
Project engineer Harry Wilson says: "We have over 6000 units in the field. There hasn't been a friction failure in the lot. The design we developed with R/M's cooperation has been use-proven. We're well satisfied with R/M's ability to help design and then deliver a superior friction material at a competitive price."

Several types of materials were tested in R/M laboratories and then on Payloader tractor shovels. Sintered bronze was the material chosen for the friction plates. Plate speeds range from 1370 to 6140 rpm; gross plate pressure to 180 psi.

Unbiased recommendations

Wherever you are, one of R/M's 25 sales engineers can be at your desk within 24 hours to help you tackle any friction material problem. *Only R/M manufactures all types of friction materials—your assurance of unbiased recommendations!*

Send for your free copy of R/M's Bulletin No. 501. It is packed with helpful engineering information. Write today.



"PAYLOMATIC" full power-shift transmission; 3-speed, fully reversing, constant mesh, countershaft type with balanced, rotating, hydraulic clutches continuously pressure-filled, cooled and lubricated.

This sintered friction plate, OD 5 1/4 in., is used in an oil-immersed application in "PAYLOMATIC" transmissions. The number of plates and the ratios vary between the models to meet torque requirements.



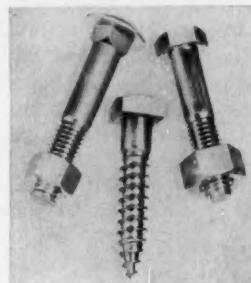
NEW PARTS AND MATERIALS

in printed circuitry since it has infinite dimensional fidelity, does not outgas or carbon track, will not absorb moisture or support combustion, is radiation resistant, and maintains a volume resistivity of $+10^6$ ohms per cm through 300°C. The 0.0005-in. copper conductive path is located within holes, or in grooves or counterbores on either or both surfaces of the circuit board. More than 5 lb static load is required to break off a 20-gage wire when soldered to a 1/8-in. bull's-eye. Any solder melting below 300°C may be used. Boards are available in sizes to 19 x 29 in. Electronic Mechanics Inc., 101 Clifton Blvd., Clifton, N. J.

Circle 639 on Page 19

Plated Fasteners

are highly corrosion resistant



New line of Stanscrew plated fasteners includes hex cap screws, hex and hex screws, carriage bolts, lag screws, and hex nuts in more than 250 different types and sizes. Particularly desirable for applications requiring extra corrosion resistance, fasteners incorporate fine zinc plating. Standard Screw Co., 2701 Washington Blvd., Bellwood, Ill.

Circle 640 on Page 19

Miniature Check Valve

for operating pressures to 1000 psi

Lightweight, miniature, in-line check valve permits free fluid flow in one direction and checks reverse flow. Valve is designed with one end for installation into a valve body and the opposite end for tube connection. Large, straight-line flow passages assure low pressure drop and minimum loss of power.



RAYBESTOS-MANHATTAN, INC.

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**your guide
to the
gear pump
for your
application**

This new catalog is an invaluable directory to no less than 129 pump-and-electric-motor-combinations — any and all available off-the-shelf!

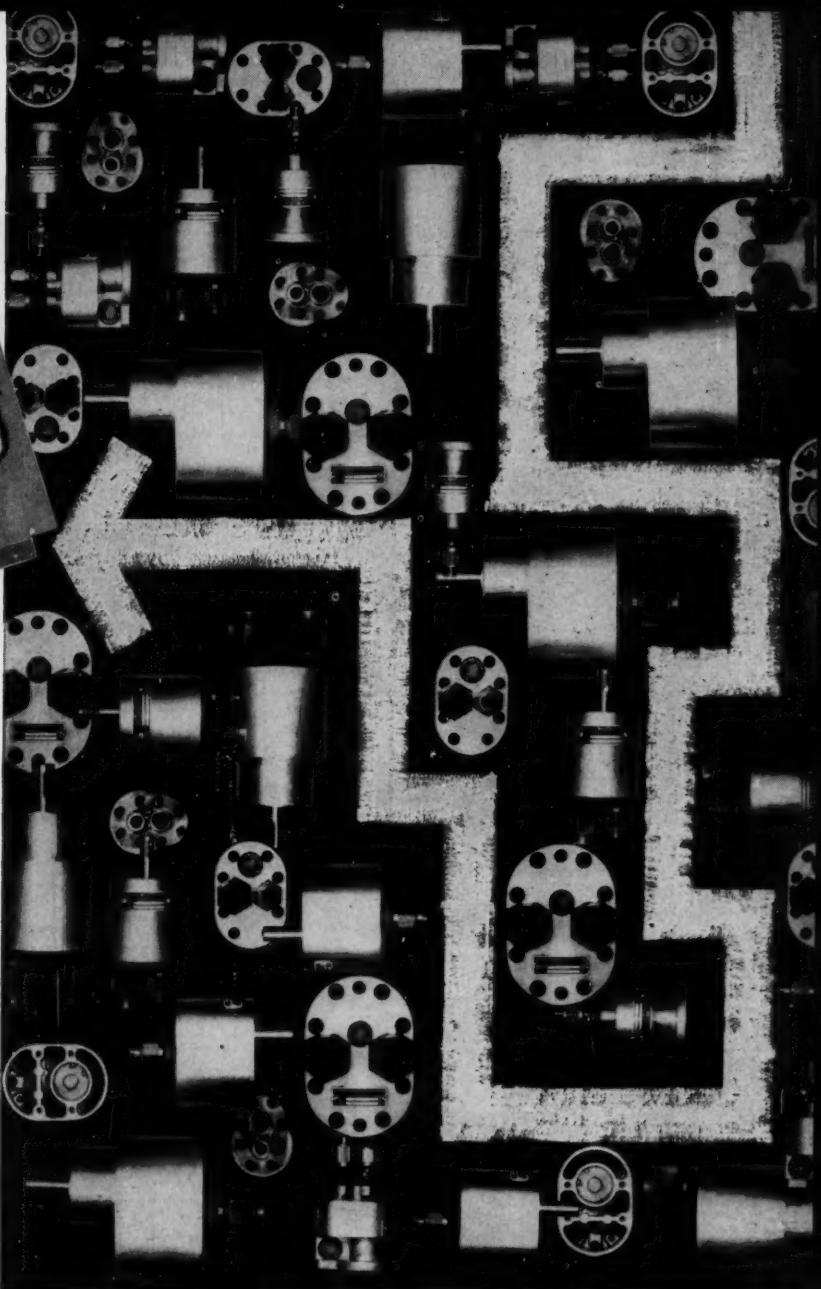
Searching for gear pumps with top volumetric efficiencies? Do your performance requirements fall into one of these three major groups?

- Eastern 1200 series — up to 1.6 gpm — pressures to 800 psi
- Eastern 100 series — up to 5 gpm — pressures up to 1500 psi

Other Eastern products:

- hydraulic motors
- positive displacement pumps
- centrifugal pumps
- aircraft pumps

Circle 479 on Page 19



- Eastern 700 series — up to 9.8 gpm — pressures up to 1500 psi

If one or more of these performance ranges measures up to what you need, save hours of searching your way through the gear pump maze — send for catalog 810 now!

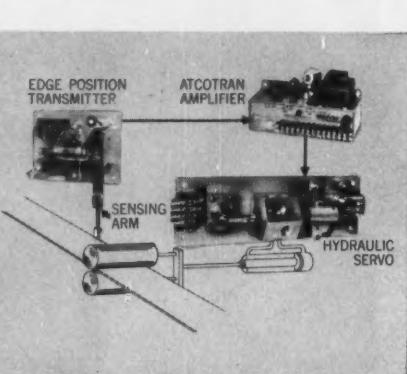


**EASTERN
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Hamden, Connecticut

DISPLACEMENT PICK-UPS FOR MACHINE AUTOMATION

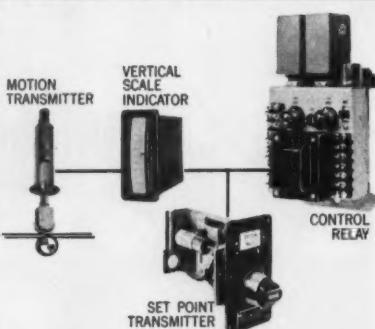
EDGE CONTROL

Atcotran Edge Guide Control maintains constant, precise edge positioning (within 0.001") for accurate register of moving web. Range is 2 1/4" with only 1/4 oz. pressure on edge. Stable null balance circuit. For paper, metals, textiles, plastics, etc.



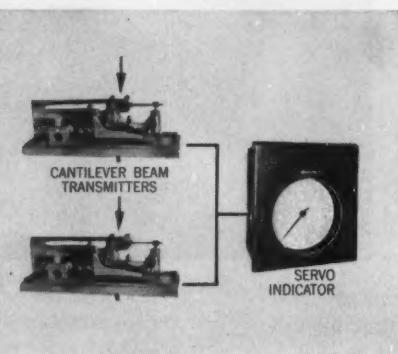
THICKNESS MEASUREMENT

ATC measuring devices for reliable automation control systems. Indicates and controls thickness to adjustable pre-set tolerance. Ideal for wallboard, sheet metal, plywood, plate glass, etc.



WEIGHT SUMMATION

ATC Cantilever Load Cells change force (or weight) to electrical signal, recorded as weight on servo indicator. Multiple load cells may be algebraically coupled for indication-control of force, thrust, torque, etc.

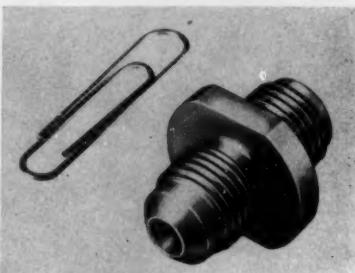


ADVANCED DIFFERENTIAL TRANSFORMER PRINCIPLE permits simple and rapid automation of machine functions using standard off-the-shelf control components, indicators, recorders, and process controllers. Discuss your applications and requirements with your ATC representative.

AUTOMATIC TIMING & CONTROLS, INC.
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A Subsidiary of American Manufacturing Company, Inc.

ATC, Div. of Interprovincial Safety Industries, Ltd., 5485 Notre Dame St., West, Montreal 30, Quebec

NEW PARTS AND MATERIALS



Weighing less than 1 oz, valve has a one-piece, leakproof, aluminum body and hardened, stainless-steel poppet and spring. Built for operating pressures to 1000 psi, valve cracks at 5 to 8 oz-in. and has a flow capacity of 1 gpm. It handles any fluid compatible with the materials in a -65 to +450 F temperature range. **Fluid Regulators Corp.**, 313 Gillette St., Painesville, Ohio.

Circle 641 on Page 19

Teflon Balls

withstand high compressive forces

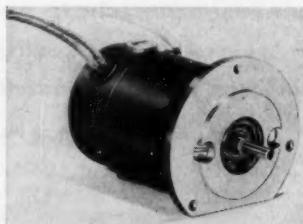
Diameter and sphericity tolerances of Teflon balls are maintained within 0.001 in. Teflon provides chemical inertness, absence of need for lubrication, and resistance to temperature extremes. Balls withstand unusually high compressive forces without permanent distortion or failure. Operating temperature range is from cryogenic to above 500 F. **Tri-Point Plastics Inc.**, 175 I. U. Willets Rd., Albertson, L. I., N. Y.

Circle 642 on Page 19

Miniature Motors

incorporate ball bearings

DS-105 precision miniature motors are continuous or intermittent-duty units which meet JAN specifications for small motors and are approved per military specifications.





RBW FASTENER BRIEFS

RUSSELL, BURDSALL & WARD BOLT AND NUT COMPANY



Technical-ities

By Fred E. Graves

Fastening of rigid joints

Theoretically, there's no such thing as a rigid joint. There's always some elasticity of the fastened metals. For practical purposes, you can consider a joint rigid when the bearing areas of the metal-to-metal fastened members will not crush or yield before the full load-carrying capacity of screw or bolt is developed.

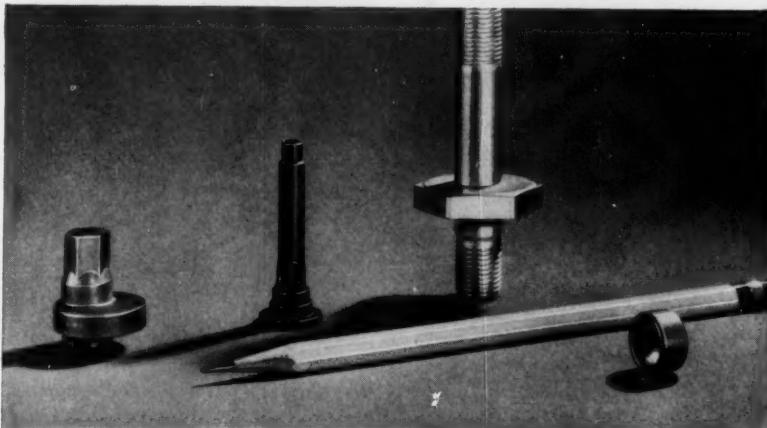
PRODUCT BENEFITS

Rigid joints afford a definite product advantage. They can take high strength hex screws or bolts tightened up to fastener yield strength or beyond. Under such tension, fasteners have demonstrated that they'll stay tight despite vibration. They are resistant to fatigue from the constant load reversals. High Strength Hex Screws cut costs and speed assembly too, since you can reduce size of the fasteners or their number, while actually improving joint strength.

INSTALLATION HINTS

When you're connecting steel members of fairly heavy section, you've no problem getting a rigid joint. Just clamp them to the full fastener capacity. Thin sections can be reinforced and similarly fastened. And in joining milder steels or softer metals, use of a plate washer will distribute bolt load, prevent crushing and give the desired effect of rigidity.

When to plan on cold-formed special parts



COLD forming is basically a large volume, low cost method of obtaining component parts.

Above you see four specific types of parts that benefit from this production method:

ECCENTRIC SHAPES

When the piece is radically eccentric, and is further complicated by having several different diameters, cold forming may prove the only way to produce the piece at a reasonable cost. Machining it from a bar would be prohibitive in scrap loss and machining time.

MULTI-DIMENSIONAL DESIGNS

When pieces are complicated, cold formers can often shape item in two or three blows. Tolerances are close enough for practical uses, and no further finishing need be done except for some secondary machining or drilling if required by the design.

ONE-PIECE PARTS

When simple, small two- or three-piece assemblies can be replaced with unit parts, the production man saves assembly time as well as mate-

rial costs; the designer gets a stronger part. For example: stud with integral hex, square, or round upset anywhere in-between. Note the extreme upset shown.

PARTS WITH HOLES

Nut formers produce parts by the thousands per hour like the one shown above. Holes are punched out, leaving smooth, clean, work-hardened and strengthened surfaces.

Bear in mind that unlike machining, cold forming cuts none of the metal's flow lines. So parts are tougher and more fatigue-resistant, as well as more economical.

As a fastener manufacturer, RB&W makes an ideal and experienced source of supply for such items. The same facilities used for standard screws and nuts can also pound out the required specials. Refer your problem to Russell, Burdsall & Ward Bolt and Nut Co., Port Chester, N. Y.

Plants at: Port Chester, N. Y.; Coraopolis, Pa.; Rock Falls, Ill.; Los Angeles, Calif. Sales office and warehouse at: San Francisco, Calif. Additional sales offices at: Ardmore (Phila.), Pa.; Pittsburgh; Detroit; Chicago; Dallas.

Lepel
HIGH FREQUENCY
Induction
HEATING
UNITS

Lepel induction heating equipment is the most practical and efficient source of heat developed for numerous industrial applications.

Typical Induction Heating Applications

Steel Bosses Selectively Hardened

Bosses on part shown are locally hardened to increase resistance to wear and plastic yielding. Surface hardening by induction provides hardness pattern indicated and hardness of Rockwell C 57/59 for 1040 steel when quenched in water.

Our engineers will process your work samples and return the completed job with full data and recommendations without cost or obligation.

Hot Forming Aids Production Assembly of Nippers

The ends of high-strength steel rivets are selectively heated to 1700° F for hot upsetting. Design of coil permits movement of upsetting tool through the coil.

WRITE FOR NEW LEPEL CATALOG

Lepel HIGH FREQUENCY
LABORATORIES, INC.

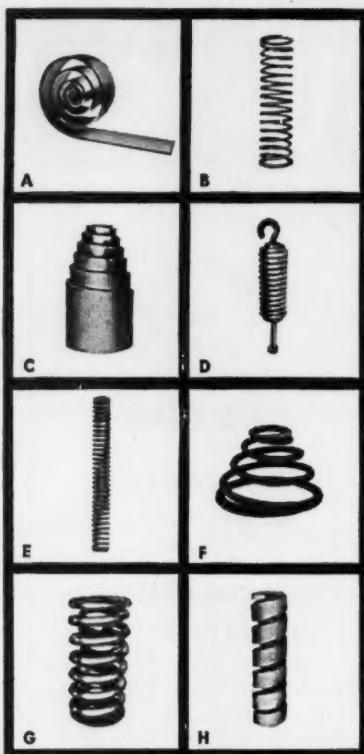
55th ST. & 37th AVE., WOODSIDE 77, N.Y.
CHICAGO OFFICE: 6246 WEST NORTH AVE.

NEW PARTS AND MATERIALS

Incorporating ball bearings, the motors are available for dc operation as shunt-series or split-field motors or as ac series-type universal units. Output ranges from 6 to 115 v. At 8000 rpm, the dc version develops 1/100 hp and the ac version develops 1/200 hp. Weighing 11 oz, motors are 2.562 in. long, plus a standard 1-in. shaft. Other shaft lengths to fit special needs are available. Maximum shaft diameter is 0.250 in. OD of the steel-shell housing around motors is 1.687 in. Motors are available with or without flange-mounting bracket. Heinz Mueller Engineering Inc., 4725 W. Iowa St., Chicago 51, Ill.

Circle 643 on Page 19

**Can you identify
these springs?**



A. flat B. helical C. volute D. extension
E. helical F. cone G. helical, triple-coil
H. rectangular section

**Over One Million
ALCO SPRING
DESIGNS**

ALCO's complete line of "performance-rated" springs ranges from small springs for light work to heavy-duty triple-coil springs for heavy, sustained work.

In over 80 years, ALCO engineers have produced more than one million spring designs to serve almost every conceivable application.

For your next spring job, contact your nearest ALCO sales office. To obtain brochure, *ALCO Springs for Industry*, write to ALCO Products, Inc., Dept. 160, Schenectady, N.Y.

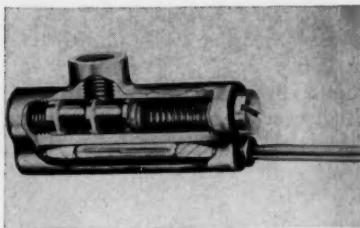


ALCO PRODUCTS, INC.
NEW YORK
SALES OFFICES IN PRINCIPAL CITIES

Flow Switch

has only one
moving part

FS-925 flow switch is a low-cost, low-capacity unit that actuates on a preset flow rate. Highly sensitive, it is extremely dependable for



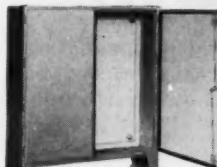
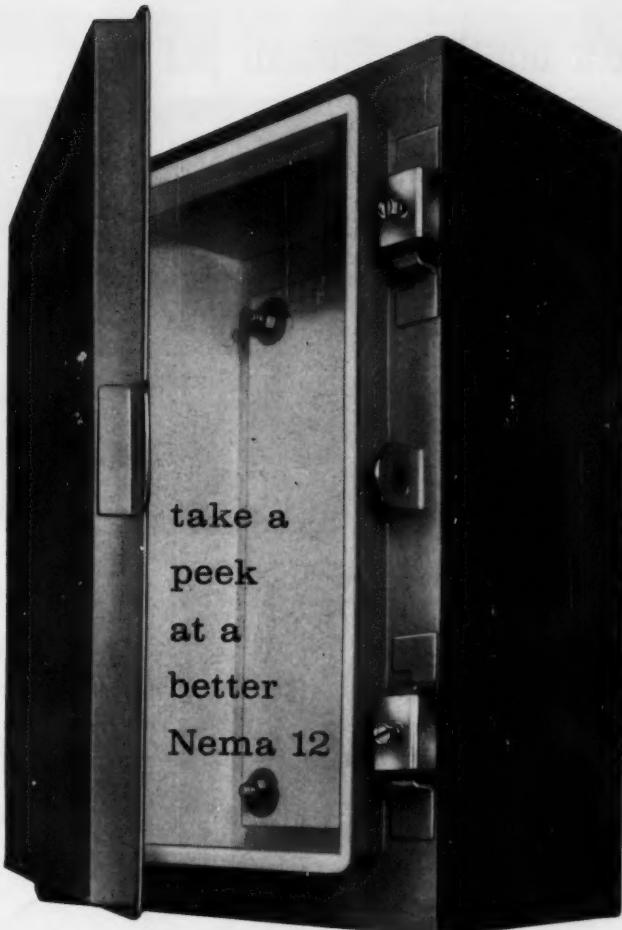
detecting flow or lack of flow in small piping and tubing systems. Pressure differential of less than $\frac{1}{2}$ psi displaces the magnet-equipped piston. Permanent magnet in turn actuates the hermetically sealed switch contacts. All-bronze construction and single moving part provide complete reliability. The $\frac{1}{4}$ -in. NPT ports permit the use of standard piping. **Gems Co. Inc.**, Sheppard Lane, Farmington, Conn.

Circle 645 on Page 19

Door Interlocks

eliminate cheaters
and jumpers

Three door interlocks feature a maintained-contact actuator position for checking hazardous electrical equipment. Interlocks automatically cut power to electrical components when service door is opened and turn it back on when door is closed. For checking equipment without using jumpers or cheaters, actuating plunger is pulled to maintained-contact position to keep power on. When door is closed, actuator automatically returns to normal position. Two series, 22AC and 23AC, differ only in the shape of the mounting bracket and location of mounting holes. Model 24AC, which controls two separate circuits at the same time, uses two switches. All three series feature high-strength thermoplastic actuating rods which have self-lubricating, low-friction properties for long life. Switches



NEMA 12
Cabinets



JIC Pull Boxes



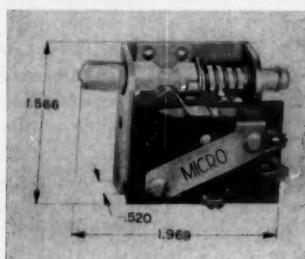
Pushbutton
Enclosures

Open the door of a Keystone Nema 12 cabinet . . . and you'll see the unmistakable sign of quality. A positive, liquid-tight seal, plus durable construction and finish—make these enclosures perfect protectors for all types of electrical and electronic controls.

Keystone has a wide range of both single and double door models in stock, all built exactly to JIC and Nema specifications. Special sizes can also be quickly produced to meet unusual application requirements.

So better yet, *take a good, long look* at what Keystone has to offer in the way of Nema enclosures . . . you'll be glad you did.

Write for your new Keystone Catalog
of JIC and Nema 12 Wiring Enclosures



KEYSTONE
MANUFACTURING COMPANY
DIVISION OF **AVIS** INDUSTRIAL CORPORATION
23332 Sherwood Ave. • Warren, Michigan

Here's another unusual job*



WELL
DONE
BY



SPENCER VACUUM

* In manufacturing woven felts used in papermaking, singeing is sometimes necessary to remove excess wool nap. But then the problem arises: how to remove the singe dust—evenly, smoothly, and without affecting color and texture of the felt.

Machinery and Equipment Development Engineers and Purchasing at the Huyck Felt Co. in Rensselaer, New York found the answer. Working with Spencer people, they developed a system which... operating through a "floating" pick-up tube (as shown above)... utilizes vacuum to do the job—cleanly, precisely, quickly.

Perhaps vacuum can help solve your unusual design problem. We'll be glad to offer suggestions—at no obligation.



Request Catalog No. 155B,
"Spencer Vacuum"

The **SPENCER**
TURBINE COMPANY
HARTFORD 6, CONNECTICUT

NEW PARTS AND MATERIALS

are rated for 10 amp at 125 or 250 v ac; $\frac{1}{2}$ amp at 125 v dc; $\frac{1}{4}$ amp at 250 v dc; $\frac{1}{2}$ hp at 250 v ac. Micro Switch Div., Minneapolis-Honeywell Regulator Co., Freeport, Ill.

Circle 646 on Page 19

High-Temperature Thermostat

for temperatures from
-65 to +520 F

Type HT-500 thermostat is a snap-acting temperature control for applications where a sealed unit and high vibration resistance are required, such as gasoline and diesel engines, compressors, and exhaust systems. Unit is especially designed



for air-cooled engines where it serves to shut off the magneto at head temperatures of 400 to 520 F. Other features include ease of installation, completely sealed construction, high-temperature fused-glass insulation, and extreme ruggedness. Unit is single pole, single throw, normally open or closed. Temperature setting range is -65 to +520 F. Therm-O-Stats Inc., P. O. Box 303, Chartley, Mass.

Circle 647 on Page 19

Safety Switch

30-deg tilt of appliance
opens the circuit

TO safety switch utilizes the principle of a suspended weight maintaining its vertical position at all times. When properly mounted in an appliance, switch contacts are held closed until appliance is tilted 30 deg or more. At this point the vertical weight remains in position and exerts a lifting motion on the operating contact spring, which opens the circuit. Applications in-



Smallest, Fiercest of mammals, the mole-like, fractional-ounce shrew consumes several times its own weight of insects daily — may even kill and eat mice many times its own size. In fact, this little lightweight is so formidable that its name has been adapted to classify certain human traits; for example, "shrewish" and "shrewd".

Ideal For Missiles and other space-saving applications, this tiny rotary actuator meets military specifications for high speed torque. Measuring $2\frac{1}{8}'' \times 2\frac{1}{4}'' \times 1\frac{1}{8}''$ it is 50% smaller, weighs 50% less, than its predecessor. MPB bearings, first selected as shaft supports for special models, proved so satisfactory that they are now specified on standard models.

Man With Miracles. Like all MPB Sales Engineers, Ray Sparks has had considerable experience in helping designers choose exactly the right MPB bearings for best results in miniaturization or in instrumentation—or in both. He is well qualified to bring expert advice to your own product development and solution of problems in these fields.

Miracles in Instrumentation



ACTUAL SIZE OF THE MPB BEARING
IN ACTUATOR SHOWN ABOVE

Specialized customer service is one of the most valued features of MPB engineering. In addition to developing new precision bearings for miniature and precision applications, the news-making MPB Technical Center at Keene provides customers with constant teamwork in the development of modern mechanisms. For details about MPB service—and for a catalog on MPB bearings, the world's largest line — write to **Miniature Precision Bearings, Inc.**, 82 Precision Park, Keene, N.H.

MPB *Helps you perform
miracles in instrumentation*



**are small
precision metal parts
ruining your
appetite?**

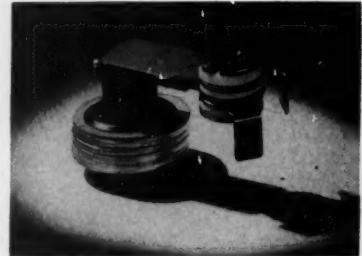
Do you look at the Chef's Special and see only small precision metal parts? Does your caviar taste like old production orders? What you're suffering from is small component indigestion . . . and Torrington is the specialist to cure it.

Manufacturing special metal parts is a full-scale business with us. We're geared to turn out whatever you need with the precision, finish, temper and hardness you need . . . turn it out at high speed at a cost surprisingly lower. We have the specialized skill and engineering experience to handle the job from start to finish.

If you need special parts in large quantities, don't decide anything until you've called us. Better still, send us a blueprint of the part you want. Our estimate will be prompt and accurate.

progress through precision **SPECIAL METAL PARTS**

THE TORRINGTON COMPANY Torrington, Connecticut



clude hair dryers, vaporizers, open ovens, and room heaters. Norwalk Thermostat Co., Woodlawn Ave., Norwalk, Ohio.

Circle 648 on Page 19

Organic Fiber

**will not conduct
heat or electricity**

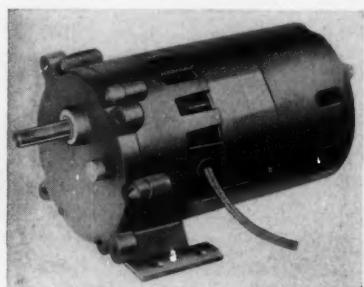
Pluton all-organic, heat-resistant fiber retains its flexibility and part of its strength after exposure to intense heat. Available as a fabric, it also can be worked into laminates reinforced with high-temperature phenolic resin to form structural parts or molding compounds. Fiber is entirely free of elemental carbon and conducts very little heat or electricity; it does not char or melt. Minnesota Mining & Mfg. Co., 900 Bush Ave., St. Paul 6, Minn.

Circle 649 on Page 19

Gear Motor

**continuous-duty unit
assures quiet, long life**

VW-22 subfractional, four-pole, shaded-pole gear motor is available in 1/30, 1/60, and 1/100-hp sizes, in nine speeds from 1 to 200 rpm. Unit is designed for continuous duty, and operates at low speed, assuring quiet, long life. Motor is less than 6 in. long, less than 4 in. in diam, and weighs between 4 and



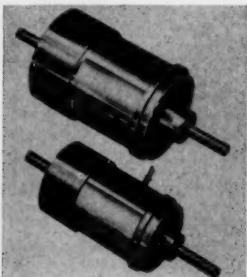
6 lb. It is fan cooled, with precision-cut gears and oil-impregnated bronze bearings. Von Weise Gear Co., 9353 Watson Industrial Park, St. Louis 26, Mo.

Circle 650 on Page 19

Brake-Clutch Components

in size 8 and 11 provide fast stopping or starting

Two electrically operated brake-clutch components in size 8 and 11 have standard BuOrd mountings. They are available for use in motor-potentiometer, motor-gearhead, or other control-assembly configurations requiring fast stopping or starting, or in systems requiring engagement or disengagement from continuous



uously running driving sources. Size 11 brake-clutch weighs less than 5 oz and is 1.839 in. in length, exclusive of shafts. Minimum brake or clutch torque is 16 oz-in., and total response time from brake-disengage to clutch-engage is 23 msec. Unit is designed for 28 v dc operation. Size 8 unit is 1.530 in. long and weighs 2.5 oz. General considerations are similar to the size 11, but brake-disengage clutch-engage time is faster, 12 msec. Torque for braking or clutching is 8 oz-in. minimum. **Bowman Instrument Corp.**, 8000 Bluffton Rd., Ft. Wayne, Ind.

Circle 651 on Page 19

Small Valves

for operating pressures to 100 psi

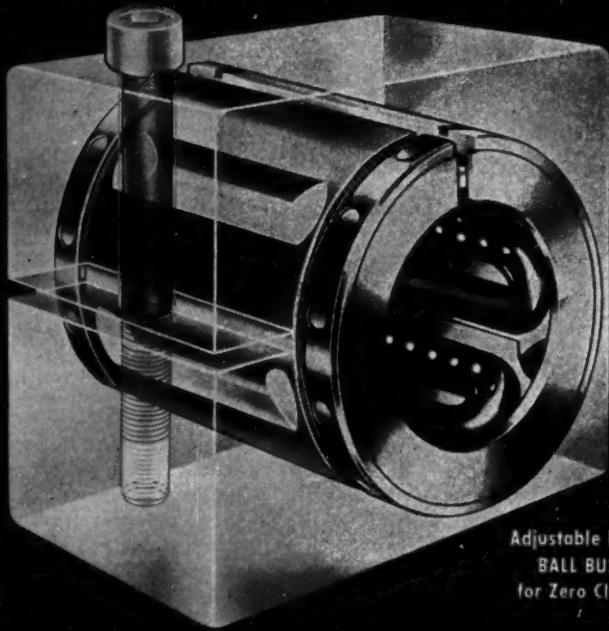
Three-way Micro valves feature male pipe connections which turn, permitting installation without the use of unions. Valves, which provide fast, positive snap-action, can be manifolded together easily for

February 2, 1961

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Adjustable Diameter and Open
THOMSON

BALL BUSHINGS



Adjustable Diameter
BALL BUSHING
for Zero Clearance

The BALL Bearing
for all your

LINEAR MOTIONS



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Low Cost Series "B" BALL BUSHING



Open BALL BUSHING
for Zero Clearance on
Supported Shafts

Sliding linear motions are nearly always troublesome. Thousands of progressive engineers and designers have solved this problem by application of BALL BUSHINGS on guide rods, reciprocating shafts, push-pull actions, or for support of any mechanism that is moved or shifted in a straight line.

Improve your product! Up-date your design and performance with Thomson BALL BUSHINGS!

**LOW FRICTION • ZERO SHAKE OR PLAY
ELIMINATE BINDING AND CHATTER
SOLVE SLIDING LUBRICATION PROBLEMS
LONG LIFE • LASTING ALIGNMENT**

The various types cover a shaft diameter range of $\frac{1}{8}$ " to 4". Small sizes available in Stainless Steel. Write for literature and name of our representative in your city.



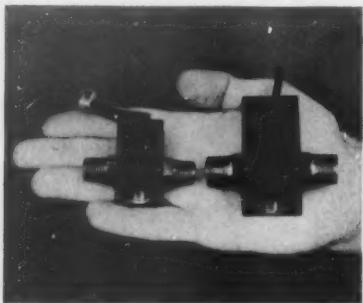
THOMSON INDUSTRIES, Inc.

Dept. E, MANHASSET, NEW YORK

Circle 488 on Page 19

Also Manufacturers of NYLINED Bearings... Sleeve Bearings
of DuPont Nylon, and 60 CASE... Hardened and Ground Steel Shafting

NEW PARTS AND MATERIALS



multiple operation. They are available for operating pressures to 100 psi in a variety of orifice sizes, materials, and types of operators. Instruments Inc., P. O. Box 556, Tulsa, Okla.

Circle 652 on Page 19

Flexible Plastic

carries solvents at temperatures to 175 F

Flexible plastic which resists most chemicals and solvents makes possible lightweight, flexible, reinforced ducting and tubing in diameters

from 1 to 4 in. in a variety of lengths. Dynaflex P-5932 safely carries solvents in liquid and vapor form at temperatures to 175 F. It successfully resists fuels, bases, and organic solvents including most aromatics and alcohols. While some organic solvents may cause swelling, material still retains its strength and impermeability. It is available for applications such as custom ducting, and suction and low-pressure hose, wherever resistance to solvents is required. Hose can be furnished in both compressible and stretchable forms. Dayton Dayflex Plastics Co., Div., Dayco Corp., Dayton, Ohio.

Circle 653 on Page 19

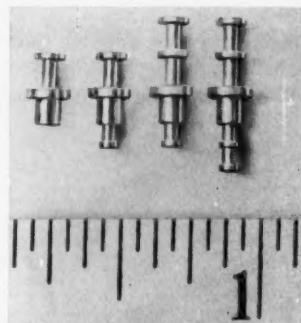
such as connectors, cams, gears, and coil forms. Material molds at extremely low pressure and can be used without difficulty in all types of automatic equipment. Material has continuous heat resistance of over 450 F. Rogers Corp., Rogers, Conn.

Circle 654 on Page 19

Terminals

withstand heavy wiring

Two Cambion feed-through terminals and two stand-off terminals are designated No. 1040, 1041, 1042, and 1043. They are designed to withstand heavy wiring in produc-



Molding Material

has high heat resistance

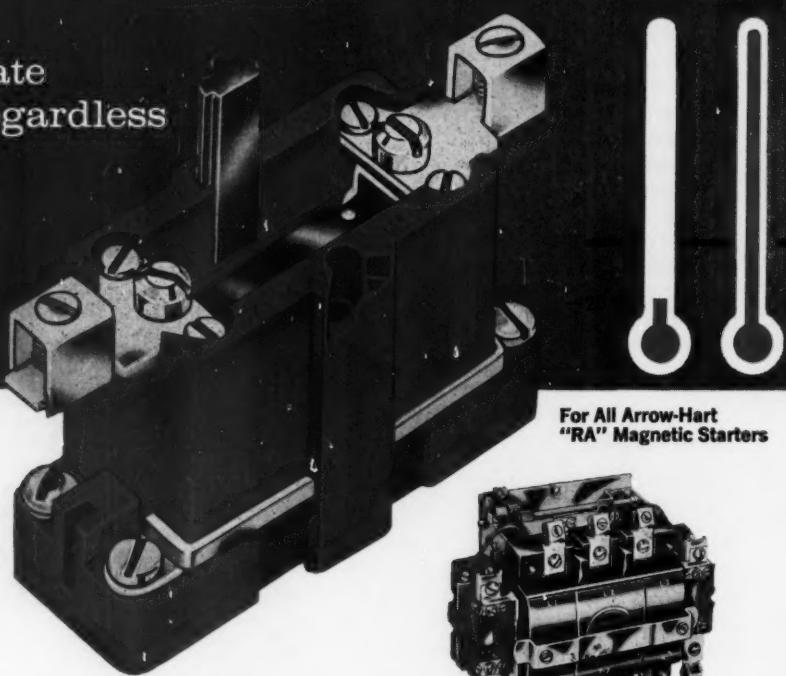
RX 600 molding material is a glass-reinforced phenolic which offers excellent electrical properties in the presence of moisture, in addition to excellent heat resistance, dimensional stability, and flame resistance. A high-temperature molding material, it is intended for critical insulation and structural applications

ARROW AH HART

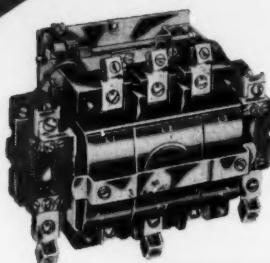
NOW, Reliable, accurate
overload protection regardless
of HEAT or COLD!

NEW

AMBIENT
COMPENSATED
OVERLOAD RELAYS
with "Balancing Bi-Metal"
exclusive with
ARROW-HART



For All Arrow-Hart
"RA" Magnetic Starters



Nema Sizes 0 through 5

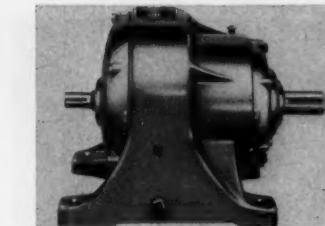
tion and prototype work. No. 1040 is a single-turreted, stand-off terminal. No. 1041 is a feed-through terminal with a single turret at each end. No. 1042 is a feed-through terminal with a double turret at one end and a single turret at the other. No. 1043 is a feed-through terminal with double turrets on each end. All four terminals have shank diameters of 0.090 in. Terminals are brass per QQ-B-626a, Comp. 22½ hard, finished in 0.003-in. silver plate plus water-dip lacquer. Cambridge Thermionic Corp., 445 Concord Ave., Cambridge 38, Mass.

Circle 655 on Page 19

Speed Reducers

are furnished in two gear-train constructions

Double-reduction Syncogear speed reducers incorporate an improved gear arrangement for low-speed, high-torque, extra-capacity working performance. Reducers are provided in two types of gear-train construction, depending on the rating of the unit. Fully hardened helical gears give maximum speed reduction and



eliminate gear breakage caused from heavy-duty loads. Reducers are driven by a separate, direct-connected motor. Direct connection can also be made on the take-off shaft, or an indirect connection by means of a V-belt or chain drive. Reducers are available in capacities from $\frac{1}{3}$ to 75 hp with ratios from 5:1 to 47.4:1. U. S. Electrical Motors Inc., Box 2058, Terminal Annex, Los Angeles 54, Calif.

Circle 656 on Page 19

Silicone Varnish

for both 180 and 220-C systems

No. 981 Class H varnish cures at 150°C in 6 hr. It is as easy to process as most Class A and Class B varnishes, eliminating the need for

NEW PARTS AND MATERIALS

high-temperature curing ovens. The dipping and impregnating varnish meets AIEE requirements for both 180 and 220-C systems. Despite the low curing temperature, varnish has greater heat stability than other varnishes. Varnish is especially suited for impregnating large electric equipment such as transformers of 500 kva or larger, traction motor armatures, motors, and generators. It also provides complete impregnation and troublefree curing for fine magnet-wire coils of electronic transformers and servo motors. Dow Corning Corp., Midland, Mich.

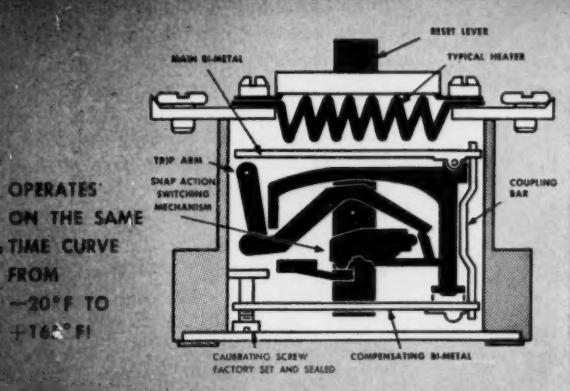
Circle 657 on Page 19

Leakage Limit Gage

precisely controls any liquid or gas

New type of leakage limit gage is adaptable in applications where a preset flow is desired from zero to a predetermined maximum flow range of approximately 500 cu cm per min. This is readily accomplished within 1 per cent accuracy

MOTOR CONTROLS



Here for the first time is a compact, dependable overload relay that compensates for both heat and cold. As shown here, the balancing or compensating bimetal and the working bimetal are identical in size and construction and are joined by a coupling bar. As the ambient temperature rises above or falls below 72°F, the balancing bimetal operates through the coupling bar to maintain the same tripping time over a temperature range from -20°F to +165°F. Compensating action is fully automatic. Relays use standard A-H Heaters and

operate equally well with either quick-trip or regular types. The switching mechanism itself employs the same positive snap-action featured in all A-H Overload Relays. Calibrating screw permits precise adjustment at the factory and needs no further adjustment. Available in ratings from 25 to 300 amperes, continuous current, these new Ambient Compensated Relays can be supplied with all sizes of Arrow-Hart "RA" Magnetic Starters . . . or as individual units for use as separately mounted relays.

FOR COMPLETE INFORMATION AND ENGINEERING DATA . . . write now to The Arrow-Hart & Hegeman Electric Company, Dept. MD, 103 Hawthorn St., Hartford 6, Conn.

ARROW AH HART

Quality since 1890

Motor Controls • Wiring Devices • Appliance Switches • Enclosed Switches

Circle 489 on Page 19



Wood's stationary control, variable speed drives, including SVS types, are available in capacities from fractional to over 300 hp using conventional V-belts. Wide range VPS types are available in capacities from 1 to 20 hp.

Write for BULLETIN 6102.



T. B. WOOD'S SONS COMPANY • CHAMBERSBURG, PENNSYLVANIA

ATLANTA • CAMBRIDGE • CHICAGO • CLEVELAND • DALLAS

SVS/2361

166

Circle 490 on Page 19

NEW PARTS AND MATERIALS



standard. Another version, the variable flow control, is furnished in the following ranges: 0 to 250 cu cm at 1 per cent accuracy; 250 to 500 cu cm at 2 per cent accuracy; 500 to 3000 cu cm at 3 per cent accuracy. Instrument can be roughly handled or disassembled, cleaned, and reassembled without any change of preset characteristics. Standard components are stainless steel unless otherwise specified. Acme Industrial Co., 200 N. Laflin St., Chicago 7, Ill.

Circle 658 on Page 19

Centrifugal Motorpumps

have 1750 rpm speed for quiet operation

Called 1750K-Line, centrifugal motorpumps are particularly suited for air-conditioning and heating installations, as an integral part of machinery where low noise level is important, and on machine tools. Units run very quietly because of the 1750-rpm operating speed. Pumping rates range from 15 to 500 gpm with heads to 110 ft. Ball-bearing motors are from $\frac{3}{4}$ to $7\frac{1}{2}$ hp, and are available in drip-proof or totally enclosed construction. Pump can be mounted in a variety of positions, providing the motor is kept higher than the pump; no special foundation or baseplate is needed for mounting. Intake and discharge nozzles are cast integrally as part of the pump casing, eliminating alignment problems and need

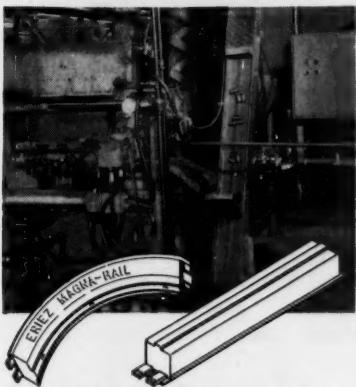


MACHINE DESIGN



ERIEZ Magnetic Minute

60 seconds that will help you improve operating efficiency.



HOW TO BUILD A PLUS into PLANT AUTOMATION systems

You can often boost the sales appeal and value of your equipment by incorporating ERIEZ Magnamation® (magnetic automation) components.

For example — ERIEZ Magna-Rails fastened under conveyor belts provide safe, positive hold of ferrous parts. They swiftly convey, control, and elevate parts up or down inclines as steep as 90°; increase safety and reduce damage by preventing slippage; save valuable floor space by permitting shorter belt spans and closer grouping of machines.

Magna-Rails are available with or without extruded aluminum covers — in 3 standard strengths and increments of up to 8' in any one section. Assembly width is 4".

ERIEZ broad experience with OEMs, designers and direct users is available to assist you in the application of magnetic components to materials handling equipment. Write to:

ERIEZ MANUFACTURING CO.
131PA Magnet Drive, Erie, Pa.



MAGNA-THOUGHT
By using exactly the right magnetic material for a given application, ERIEZ can provide each customer with precisely the right equipment to do a particular job.

W. J. Fallier
W. J. FALLIER
Product Mgr. Automation



A GROWTH COMPANY...
10 NEW PRODUCTS IN THE LAST 5 YEARS

Circle 491 on Page 19

NEW PARTS AND MATERIALS

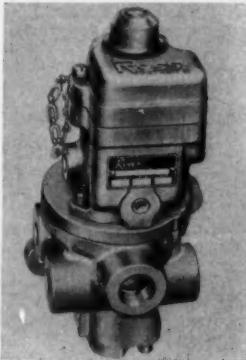
for special couplings. Casing can be rotated and set to direct the pump discharge in any of four directions, eliminating pipe joints and angles. Ingersoll-Rand Co., 11 Broadway, New York 4, N. Y.

Circle 659 on Page 19

Inline Air Valves

for temperatures from 40-175 F

Headline lightweight, inline air valves have low response time, minimum pressure drop, and long, troublefree life. Poppets achieve full flow in short travel, have Buna-N resilient poppet seals which auto-



matically compensate for normal wear. Both body and poppets are anodized aluminum alloy for maximum wear and corrosion resistance, and zinc-plated steel is used for poppet stems. Light weight of the moving parts assures rapid response, and smallness reduces impact energy to a minimum. Air or solenoid operated valves are available in straightway, three, and four-way types from 1/4 to 1 1/2-in. pipe sizes. It conforms to JIC standards, handles air or other fluid pressures of 30-150 psig in the head and 5-150 psig in the body. Temperature range of service is 40-175 F, with ambient air range from 40-120 F. Ross Operating Valve Co., 120 E. Golden Gate Ave., Detroit 3, Mich.

Circle 660 on Page 19

Pushbutton Switch

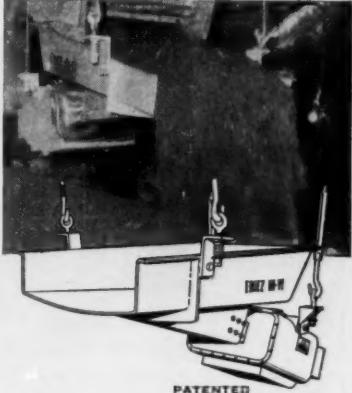
for low-power applications

Series S6 molded pushbutton switch is designed primarily for applications not exceeding 50 w. Switch is suitable for controlling relays,



ERIEZ Magnetic Minute

60 seconds that will help you improve operating efficiency.



PATENTED

HOW TO BUILD A PLUS INTO HEAVY-DUTY MATERIALS HANDLING EQUIPMENT

If the problem is feeding large tonnages of bulk materials with accurate control, consider including ERIEZ patented heavy-duty vibratory feeders in your new designs for materials handling equipment.

No rectifier is needed with ERIEZ AC powered feeders. Totally enclosed electro-permanent magnetic drive is ideal for hazardous, dusty, wet, and corrosive installations. New fibre glass springs assure superior performance and control . . . longer life because spring breakage is practically eliminated. Heavier, more rugged construction withstands severe operating conditions. Simple, compact controls require less wiring and installation time.

Illustration shows one of a number of ERIEZ units available for heavy feeding applications where big capacity and accuracy are essential. ERIEZ Hi-Vi® vibratory feeders include models with feeding capacities ranging from ounces to many tons per hour.

Write for descriptive bulletin to:

ERIEZ MANUFACTURING CO.
131PB Magnet Drive, Erie, Pa.



MAGNA-THOUGHT
Companies using ERIEZ components know we will remain faithful suppliers — not potential competitors.

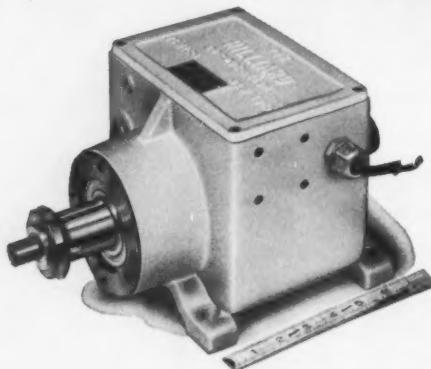
R. F. Meirwin
R. F. MEIRWIN
President



A GROWTH COMPANY...
10 NEW PRODUCTS IN THE LAST 5 YEARS

Circle 492 on Page 19

HILLIARD'S New "I.D.U."



**A complete, packaged unit
that gives you precise control
of intermittent motion from
a constant rotary power source!**

Built-in features:

- Contains all the parts in one package.
- Can be installed as easily as a motor and needs only electrical connection.
- Self-lubricating for long life of 40,000,000 or more cycles.
- Operating speed from 40 to 400 R.P.M.
- Torque capacity 36 ft. lbs.
- No cumulative error in cycling.
- Instant engagement.
- Mount with direct coupling connection or use with belt, chain or gear drive.

Can be installed on existing equipment, designed into new machinery and re-used after production line changes.

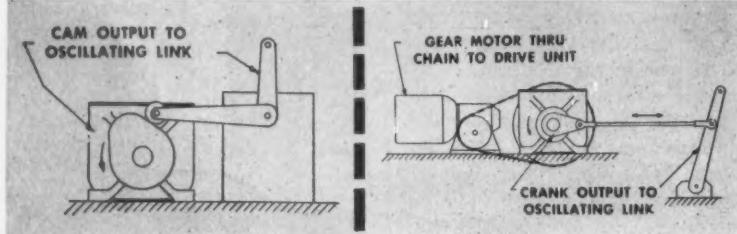
A single package unit that gives you precise control of intermittent motions . . . oscillate or repeat . . . clip and bend . . . shear or slash . . . raise or lower . . . index and position . . . from a constantly rotating source of power.

HILLIARD "I.D.U." eliminates the need of buying separate parts and assembling a "custom" machine with assorted mechanisms to control it.

"I.D.U." features highly flexible control—manual, mechanical or electrical—permitting "demand" type operations in fixed or variable cycles. A protected drive, totally enclosed in an oil bath housing, it is ideal for dusty, "steamed" or "washdown" conditions.

Write on your letterhead stating your intermittent motion problems and we will provide complete information.

Typical intermittent controls by "I.D.U."



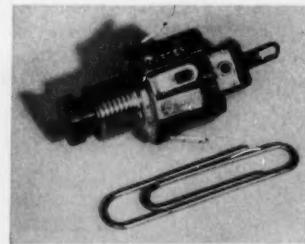
Basic Unit Price \$289.00

Optional accessories extra

The HILLIARD Corporation

103 W. FOURTH ST. ELMIRA, NEW YORK

NEW PARTS AND MATERIALS



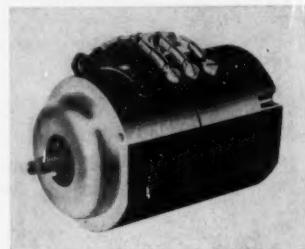
initiating meter and oscilloscope readings, pulsing counters, and panel lights. It is available with choice of button colors in open, closed, and double-throw configurations. Carter Parts Co., Dept. 21, 3401 Madison St., Skokie, Ill.

Circle 661 on Page 19

Synchronous Motor

self-orienting unit
orients within ± 5 deg

Synchronous motor in subfractional-horsepower size is a self-orienting unit. Design insures that the rotor of the synchronous motor will always synchronize at the same relative position with respect to the rotating stator field. Rotor orients within ± 5 deg, and no dc excitation of the rotor is required. Unit is rated two phase, 60 cycles, 115 v ac. Housing measures $1\frac{3}{4}$ -in. diam and 2 in. in length; complete unit weighs 10 oz. Synchronizing torque



is 0.50 oz-in. and torque (fall-out) is 0.65 oz-in. Kollsman Motor Corp., Dublin, Pa.

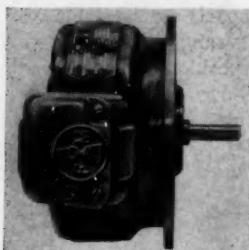
Circle 662 on Page 19

Radial Air-Gap Motor

in ratings from
 $\frac{1}{2}$ to 25 hp

LO-I radial air-gap motor in the flange-mounted construction features minimum over-all length and reduced weight with low rotor inertia. It is designed for application

where space limitations are critical and where fast acceleration, frequent start, or reversing duty is required. Line includes ratings from $\frac{1}{2}$ to 25 hp, speeds from 900 through 3600 rpm in three basic frame sizes. Several horsepower ratings in each mounting flange diameter are offered to provide flexibility of application. Choice of four different flange diameters is available in 1, $1\frac{1}{2}$, and 2-hp ratings. NEMA standard D flanges and axial air-gap motor flanges are both available.



able for maximum interchangeability. Electrical Div., Fairbanks, Morse & Co., Freeport, Ill.

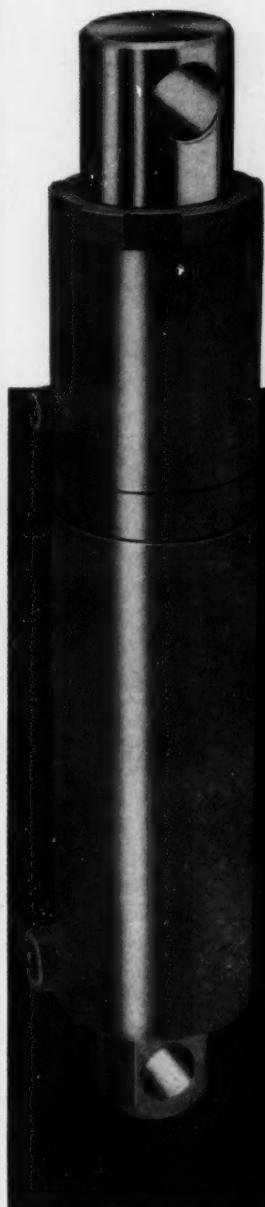
Circle 663 on Page 19

Closed-Cell Sponge

has excellent chemical resistance

Closed-cell Viton and Fluorel sponge features extremely small and uniform cell size. Product has all the chemical resistance of the standard fluorinated polymer from which it is made. Because of the expanded structure, material compares in hardness to a very soft rubber of about 20 Durometer (Shore A). Foamed version has approximately one-fourth the density of the solid product, permitting a wide range of compressibility in such applications as gaskets and mountings. In addition to excellent grease, oil, and commercial gasoline resistance, there is a marked resistance to perchloroethylene. High-temperature properties, vibration-damping qualities, excellent dielectric strength, and acid resistance suggest many applications in the electronics, missile, and automotive industries. Material is available in 9-in. square sheets in thicknesses to $\frac{1}{2}$ in. Other sheet sizes and molded shapes are available on a custom basis; both higher and lower densities can also be furnished.

CYLINDERS ARE OUR business!



BHEW precision hydraulic cylinders are designed for your job application. BHEW offers the latest developments, designs and manufacturing techniques. You pay only for what you buy and there are no extra or added expenditures. Trained specialists analyze your specific application. BHEW products are available at production prices and are precision-manufactured to produce the highest level of performance.

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data. 78 dimensional
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acting cylinders.

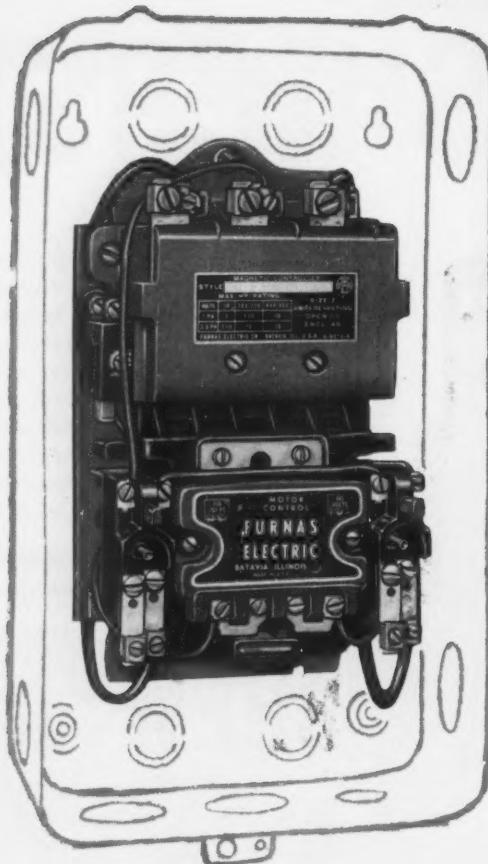
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- Application Engineering

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NEW SIZES 2 and 2½ FURNAS MAGNETIC STARTERS

Take advantage of the new design of Furnas Size 2 and Exclusive Size 2½ Starters. Rated through 30 hp, 440 volts, the Size 2½ fills many applications normally requiring a much larger Size 3 Starter. Available for two, three or four pole applications, these units feature low wattage magnet, dual voltage encapsulated coils, silver-cadmium oxide contacts, and identical mounting area for both sizes. All components are front removable. You get better performance and longer life, plus unmatched economy.

Write today for Bulletin 14-B2—1045 McKee St., Batavia, Illinois

A93



FURNAS ELECTRIC COMPANY

BATAVIA • ILLINOIS

SALES REPRESENTATIVES IN ALL PRINCIPAL CITIES

NEW PARTS AND MATERIALS

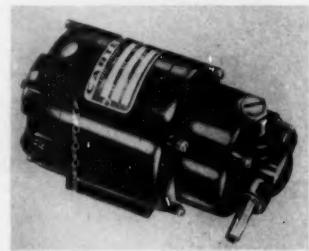
nished. Industrial Electronic Rubber Co., 31945 Aurora Rd., Solon 39, Ohio.

Circle 664 on Page 19

Gear Motors

20 models have shaft outputs of 10 to 750 rpm

Improved Classic fractional-horsepower gear motors incorporate phenolic gears to provide quiet operation and cool running. Twenty standard single and double-reduction models are available with shaft outputs ranging from 10 to 750 rpm. Shaft position is easily changed to six 30-deg positions by means of six screws. Motor shaft runs on ball



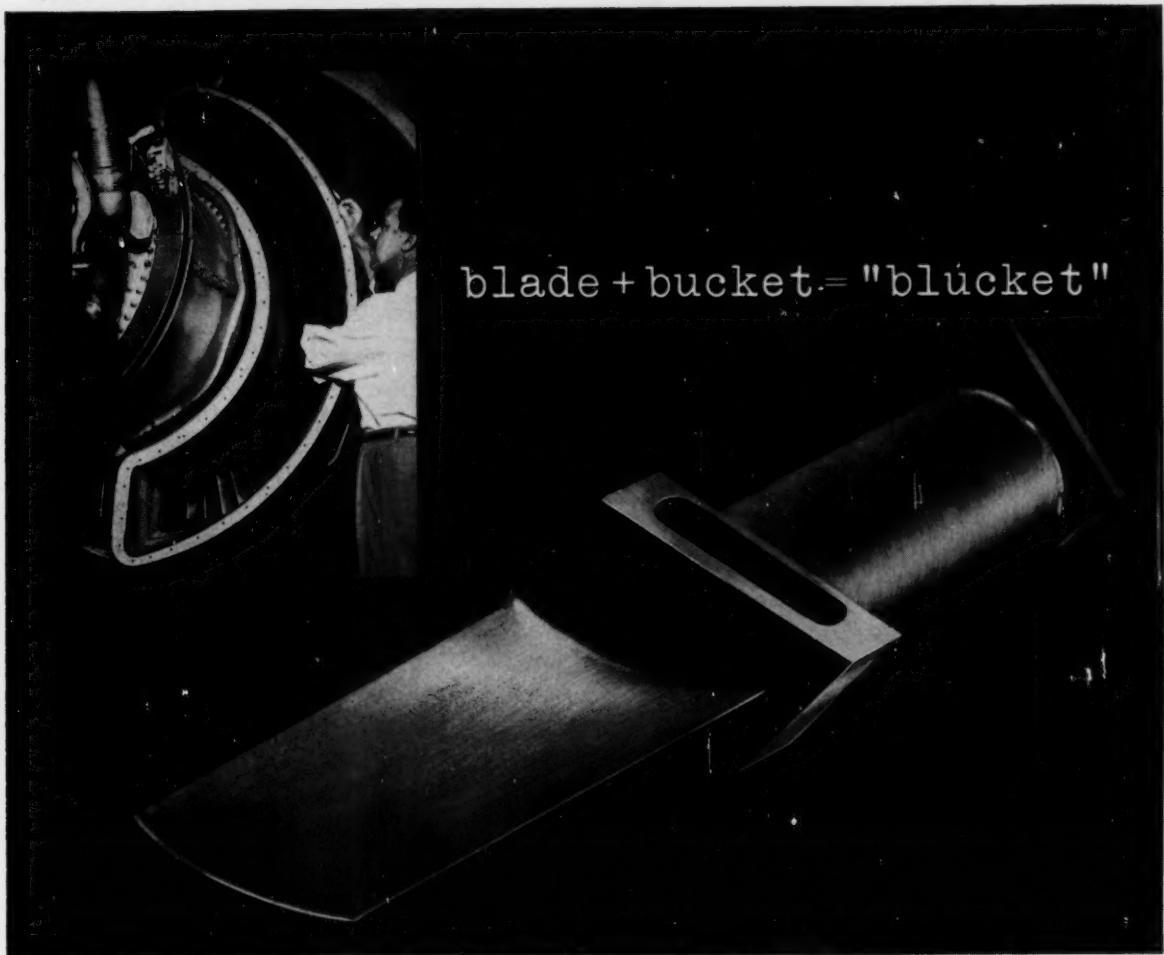
bearings, gear shafts on bronze sleeve bearings. Over-all size is 6 x 3 5/16 x 3 3/8 in., and weight is approximately 5 lb. Units are available as universal, shunt, or series motors. Inputs range from 12 to 220 v on most models, with shunt models up to 115 v dc. Carter Motor Co., 2700 W. George St., Chicago 18, Ill.

Circle 665 on Page 19

Hydraulic Relief Valves

in line and gasket-mounted types

Pilot-operated relief valves provide a minimum 5:1 safety factor over rated operating pressure. Line-mounted valves (shown) are for 3000 psi hydraulic systems, and gasket-mounted units are rated at 5000 psi. Both series are provided in rated capacities of 20 and 50 gpm. Valves can be held with standard wrenches or in a vise when installing fittings, and can be mounted in any position. Valve opening pressure is controlled by the pilot valve, which is easily adjusted and locked. Adjustment control can be installed



blade + bucket = "blucket"

new design in *Carpenter* high temperature alloy V-57

Everything about this combination fan blade-turbine bucket is new except its predictable performance . . . a built-in characteristic of all Carpenter high temperature alloys.

V-57 is the super alloy now used to forge this unique new jet engine component. V-57 replaced A-286 (originally used) because of its superior mechanical properties at operating temperatures. Like all Carpenter vacuum melted metals, V-57 is produced with exclusive Carpenter quality controls that permit tighter forging tolerances, better machinability and improved cold forming properties.

Carpenter's VACUMELTROL® (induction vacuum) and CONSUMET® (consumable electrode) melting processes assure you more accurate forgings with better finishes, fewer rejects, faster production . . . and, most important . . . true predictable performance in your high temperature alloy components. Ask your Carpenter Representative for details.

Carpenter steel

you can do it *consistently* better with Carpenter Specialty Steels for specialists



*The Carpenter Steel Company, Main Office and Mills, Reading, Pa.
Alloy Tube Division, Union, N. J.
Webb Wire Division, New Brunswick, N. J.
Carpenter Steel of New England, Inc., Bridgeport, Conn.*



GRAYLOC® Seal: Leak-proof at any pressure

Leak-proof quality of GRAYLOC Seals in piping applications has been use-proved from full vacuum to 30,000 psi and test-proved up to 150,000 psi. Holding at any pressure makes GRAYLOC practical in applications requiring positive leak-proof connections.

The GRAYLOC Seal is available in two-bolt clamp-type or conventional flange connections. Its simple steel design features a rigid rib with lips on either side tapering slightly less than the mating hub to form a line seal at the touchpoint. As the connection is tightened, the lips deflect to form a surface seal. GRAYLOC connections provide a permanent steel seal that can be made up repeatedly, operating to pressure without seal ring replacement. Stock connections available from $\frac{1}{2}$ " to 30" and on special order in corrosion-resistant metals.

If you want to know more about how GRAYLOC Connections can permanently solve your leakage problems, write for the new GRAYLOC CATALOG on your company letterhead.



P. O. BOX 2291

HOUSTON 1, TEXAS

Riverside 7-1240

NEW PARTS AND MATERIALS



in any of four positions relative to the valve for easy accessibility. Parker-Hannifin Corp., 17325 Euclid Ave., Cleveland 12, Ohio.

Circle 666 on Page 19

Rust Preventative

of transparent plastic film

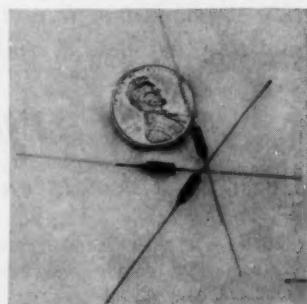
Rust Veto 342 heavy-duty rust preventative is removed easily from metal surfaces by solvent or mild alkaline cleaners. The transparent plastic dry-film rust preventive is not brittle and will not chip. It does not crack or flow at temperatures from -40 to +175 F. Material contains solvent for ease of application. It is especially designed for metal surfaces stored outdoors for long periods of time. E. F. Houghton & Co., 303 W. Lehigh Ave., Philadelphia 33, Pa.

Circle 667 on Page 19

Low-Impedance Diode

for ultrastable
reference applications

Extremely low dynamic-impedance, 6.2-v, temperature-compensated zener diode is designated Type 1N821A. It is designed for ultrastable reference applications in digital voltmeters, precision high-stability oscillators, analog-to-digital converters, and similar industrial



jamesbury "Double-Seal" BALL VALVES*

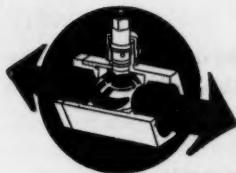
TM
*PATENTED

AS VERSATILE AS INDUSTRY ITSELF

The illustration below gives you a glimpse of the depth of application of the versatile Jamesbury "Double-Seal" Ball Valve.

For on-off, quarter turn, full flow, leakproof, maintenance-free operation, no valve can match the exclusive Jamesbury "Double-Seal" action.

We will welcome an opportunity to prove this statement, whatever your valving requirements might be.



JAMESBURY CORP., 70 NEW STREET, WORCESTER, MASS.
DISTRIBUTORS IN PRINCIPAL CITIES

© 1961 Jamesbury Corp.

403-0

1. Standard flange with PC 50 operator.
2. Screwed end type
3. 6" flange with ST 490 operator
4. 6" flange for manual operation
5. PVC screwed end type
6. Screwed-end with EM 25
7. Screwed end with PC 50 operator
8. 2" flanged valve
9. PVC flanged valve

MATERIALS:

Jamesbury "Double-Seal" Ball Valves are available in Types 303, 316 and Alloy 20 Stainless Steels, Carbon Steel, Brass, Monel, Bronze, Cast Iron, Monel, Aluminum and PVC. Other materials on special order.

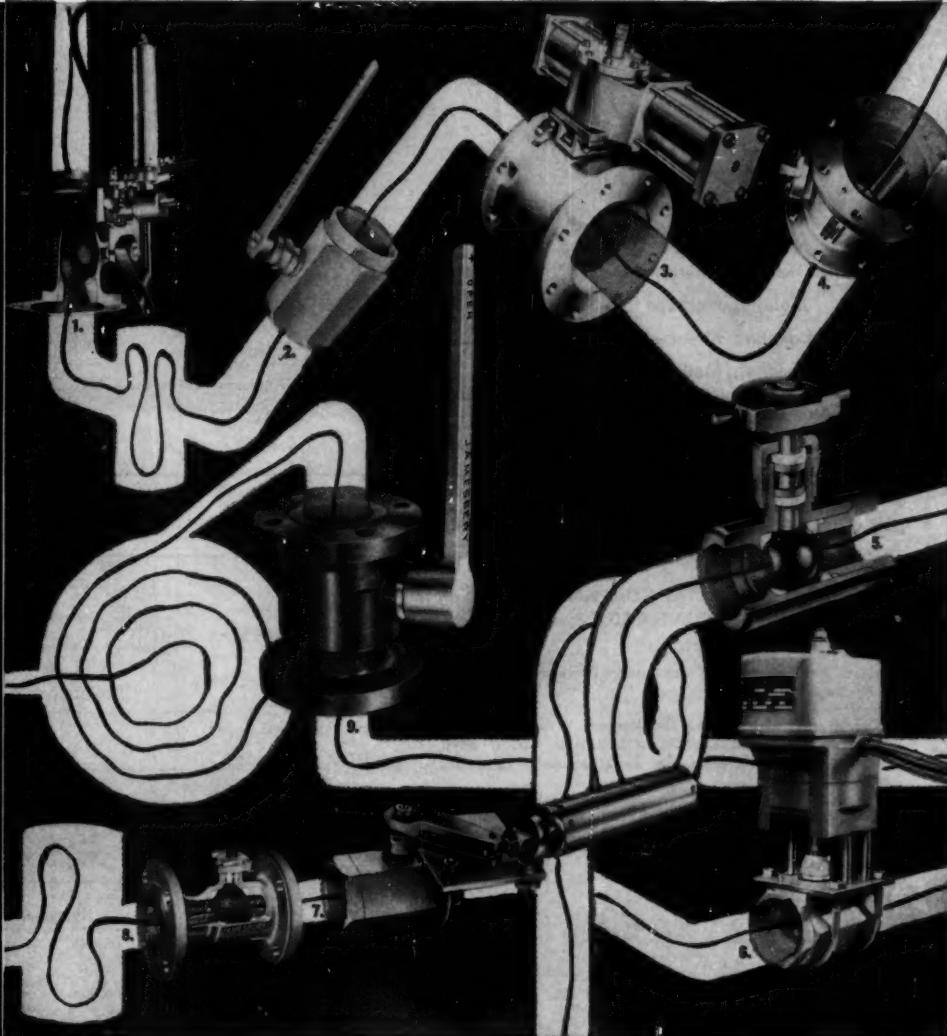
Interchangeable seals and seals are available in Teflon, Nylon, Elasta-N, Neoprene, Hypalon and natural rubbers.

Pneumatic, Hydraulic and Electric Actuator Operators to fit Remote Control Requirements.

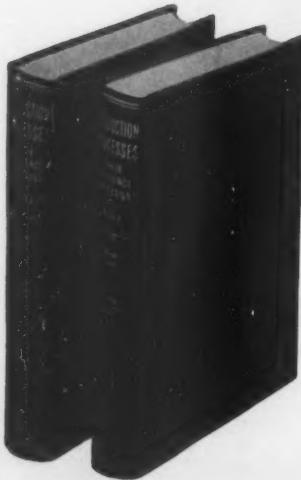
SIZES:

Screwed End: 1/4" through 3".

Flanged: 150# series — 1/2" through 12", 300# series — 1/2" through 8", 600# and 12" on application.



DO YOU HAVE THESE TWO REFERENCE AIDS?



Two of the most important books ever written for men concerned with producibility, offer practical techniques for designing for low-cost production. In effect, these two useable encyclopedias put production know-how into the hands of product development engineers.

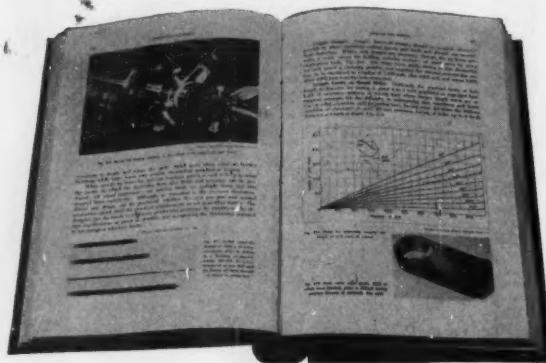
Plainly worded and clearly illustrated by one of the country's outstanding authorities on production processes, this "shop approach" to product design can be YOUR guide to lower production costs.

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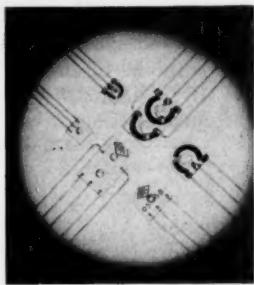
applications. Diode minimizes voltage fluctuations due to changes in current. It has a maximum impedance of 10 ohms and a typical value of 8 ohms. Unit is housed in small DO-7, axial-lead, 400-mw glass diode package. Dept. TC, Technical Information Center, Motorola Semiconductor Products Inc., 5005 E. McDowell Rd., Phoenix, Ariz.

Circle 668 on Page 19

Trimmer Resistors

line has resistances from 500 ohms to 5 megohms

New ceramic-base trimmer resistors are available for microminiature, subminiature, and miniature applications. Single-potentiometer microminiature units are rated at 1/20 w and measure $\frac{1}{4}$ x $\frac{1}{4}$ in. Sub-



miniature units are rated at 1/10 w and measure $\frac{7}{16}$ x $\frac{13}{32}$ in. in size. Miniature resistors, rated at 1/5 w, measure $\frac{7}{16}$ x $\frac{11}{16}$ in. All three varieties have a thickness of 0.100 in., and ratings are based on 1000-hr test at 70 C. Available resistances range from 500 ohms to 5 megohms, linear taper. Standard tolerance is ± 30 per cent, and minimum end resistance is less than 5 per cent of total resistance. Applications include use in cameras and hearing aids, in airborne radiation, microwave, mobile, and test equipment, and in thermostatic controls. Centralab, 900 E. Keefe Ave., Milwaukee 1, Wis.

Circle 669 on Page 19

Position Transducer

for machine-tool automation systems

Position transducer senses shaft rotation by an impedance change in



A FIST FULL OF RELIABLE POWER...

... MERKLE-KORFF FHP GEARED MOTORS

Engineers want unfailing reliability, higher starting torques, more power, more versatility, more ruggedness . . . in smaller packages.

Merkle-Korff Geared Motors are the answer. They pack more torque into fist-sized spaces (even reversers) with less weight and provide unequalled dependability. They represent not only a better buy, but better performance for equipment they power.

Versatility? Thousands of combinations of motor types, speeds, torques, brakes, fans and mounting facilities are available as standard equipment. When you specify Merkle-Korff Geared Motors, you are specifying the best.

Merkle-Korff Applications Engineers are always ready to serve you. Write or telephone, now.

TORQUE & RPM

Torques from .4 to 300 lb.-in. at 800 to 1/5 RPM. Slower or higher speeds available on special order.

MOTOR TYPES

. . . include unidirectional shaded pole induction, tandem induction reversing, wound shading coil induction reversing, unidirectional synchronous and wound armature types for universal AC-DC and shunt wound DC with lead arrangement for reversing as required. 115 volts, 60 cycles or DC is standard. Special voltages and frequencies are available.

MOUNTING POSITIONS

Horizontal or vertical up or down shafts in base mounted, no base (face mounted), inverted base or sidewall mounted designs.

OPTIONAL FEATURES

The Model BF Geared Motor may be ordered with leads, cord set, quick disconnect terminals, brakes, motor covers, thermal overload protectors, right angle shafts and various oiling arrangements.



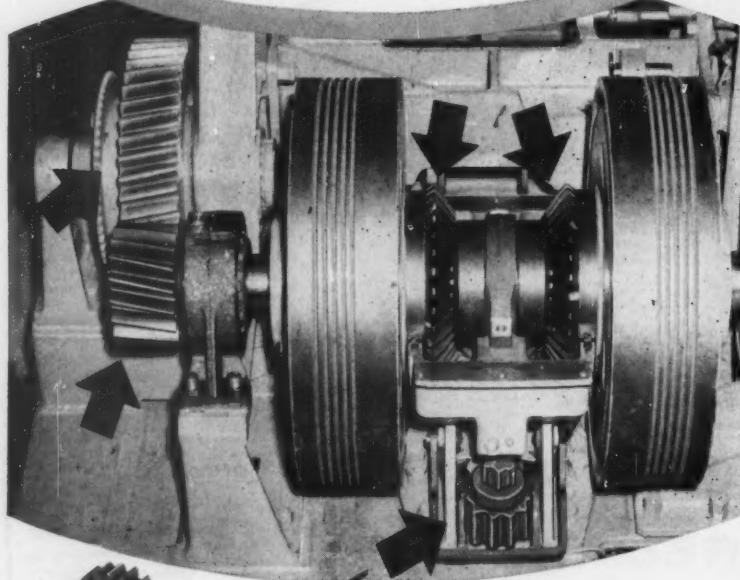
MERKLE-KORFF GEAR CO.

215 North Morgan Street • Chicago 7, Illinois

Telephone: MOnroe 6-1900

Circle 499 on Page 19

**Do You
have requirements for
"Special Gears?"**



✓ **CHECK with
FAIRFIELD!**



"Fairfield has furnished us with bevel and spur gears for many years and we are highly satisfied with their product," states one of America's best known makers of shovels, cranes, and draglines in referring to the above picture. Each gear (see arrows) is precision produced to match this builder's specifications for *plus value* quality.

Making gears to meet exacting specifications is our business. The special or unusual requirements you have for design, size, finish, tolerances, materials, and heat treatment are often "standard" at FAIRFIELD. Here, every facility needed is available for production of fine gears **EFFICIENTLY, ECONOMICALLY. LARGE or SMALL, your inquiry will receive prompt attention. CALL or WRITE.**

FAIRFIELD MANUFACTURING CO., INC.
2307 South Concord Road • Lafayette, Indiana
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Gears and Differentials

Made to Order for:

TRACTORS • HEAVY DUTY TRUCKS • AGRICULTURAL MACHINERY • POWER SHOVELS AND CRANES
MINING MACHINES • ROAD GRADERS • BUSES • STREET SWEEPERS • INDUSTRIAL LIFT TRUCKS



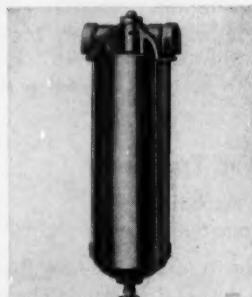
the head and changes this information to digital pulses which measure linear motion. Developed for machine-tool automation systems, transducer uses noncontact magnetic sensing heads which improve reliability and avoid wear associated with conventional code discs or other contact pick-ups. Design also saves space. Unit features low torque load and precision construction. In typical applications, unit detects 0.0001-in. increments at position speeds to 120 ipm, or 0.001-in. increments at speeds of 200 ipm or more. **Rheem Electronics Div., Rheem Mfg. Co., 5200 W. 104th St., Los Angeles, Calif.**

Circle 670 on Page 19

Filter Element

resists corrosive,
high-temperature fluids

Sintered 316 stainless-steel filter element, adaptable to any Fulflo filter, is for use with fluids with characteristics incompatible with ordinary filter media, particularly corrosive, high-temperature, and high-viscosity fluids. Unit is available in uniform 40, 20, 10, 5, and 2-micron particle-retention ratings. It is free from media migration under high differential pressures, vibration, or thermal shock. Large percentage of voids provides high dirt-holding capacity and economic flow rates with



high-viscosity fluids. Commercial Filters Corp., 2 Main St., Melrose 76, Mass.

Circle 671 on Page 19

Compact Nozzle

solders into standard $\frac{1}{2}$ -in. sweat fittings



MS-1 nozzle is available for use in limited-space applications. It solders into standard $\frac{1}{2}$ -in. copper tubing fittings and projects less than $\frac{1}{4}$ in. from the fitting. Made entirely of brass, unit has a flow rate of 1 gpm at 40 psi. Wide-angle, full-cone spray pattern is approximately a 110-deg spray angle. Bete Fog Nozzle Inc., Greenfield, Mass.

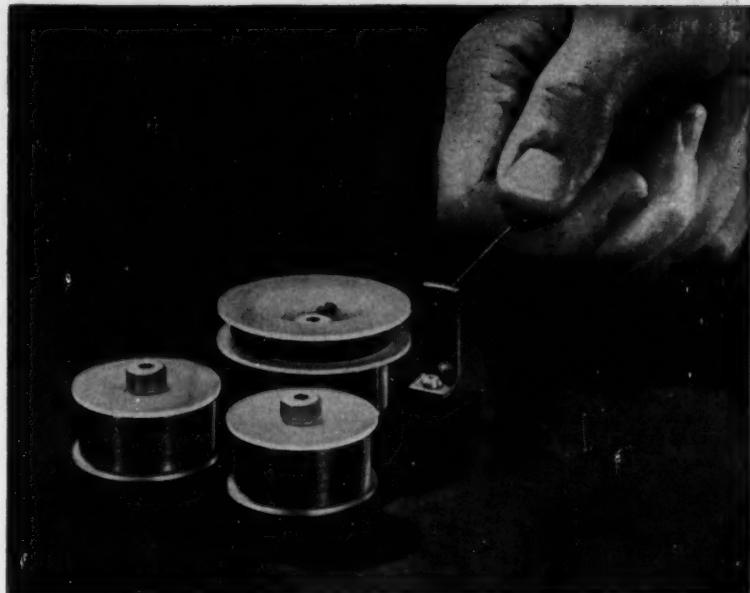
Circle 672 on Page 19

Thermoplastic Resin

resists distortion and creep at low and high temperatures

Kynar vinylidene fluoride resin is a fluorine-containing thermoplastic resin designed for long life and high performance in environments which degrade less stable materials. Containing over 50 per cent fluorine by weight, it is mechanically strong and tough, resists distortion and creep at low and high temperatures, resists the attack of corrosive chemicals, is flame resistant, and is stable under extreme conditions of weather and ultraviolet radiation. Material is now available in molding powder and pelletized resin, and soon will be supplied in rod, tube, and sheet. Standard shapes can be cut, machined, sealed, welded, and formed readily into almost any design without lowering high level of mechanical strength and stability. Research Products Development Dept., Pennsalt Chemicals Corp., P. O. Box 4388, Philadelphia 18, Pa.

Circle 673 on Page 19



NEG'ATOR® MOTORS FROM STOCK for Experimental Designers

As a time-and-cost saving shortcut for design engineers who need a means for applying constant tension forces through long deflections, Hunter now offers six stocked models of constant-torque NEG'ATOR Spring Motors.

Originally developed for use as "idea tools" for experimental design, standard NEG'ATOR Motors have found wide application as product components. For this reason, models carried in stock have been expanded to provide cable-tension ranges from 0.375 lb. through 5.0 lbs., as indicated by the table below.

Orders for stock motors will be shipped immediately. Prices are shown in the table.*

Model No.	Spring Torque in Lb.-In.	Cable Tension in Lbs.	No. Revolutions	Cable Length in In.	Endurance (Min. No. Cycles)	Price
P7172	.1	0.375	20	36	3,000	\$5.00
A2025-1	.78	1.0	15	72	7,500	8.00
A2025-2	1.56	2.0	15	72	2,500	8.00
A2025-3	2.33	3.0	15	72	4,500	12.00
A2025-4	3.12	4.0	15	72	2,500	12.00
A2025-5	3.90	5.0	15	72	2,000	12.00

P7172 MATERIALS: NEG'ATOR Springs—stainless steel; Drums—Nylon; Bases—aluminum; Cable—Nylon.

MATERIALS, OTHER MODELS: NEG'ATOR Springs—stainless steel; Drums—Nylon; Bases—Black Plastic; Cable—stainless steel, preformed.

*Prices shown are not indicative of the cost of NEG'ATOR Springs when made in quantity, to specifications, for large-volume motor and other applications.



For a good idea on how NEG'ATOR Springs are being applied, ask for Issue 12 of the NEG'ATOR SKETCHBOOK.



THE HUNTER

neg'ator
constant-force spring

HUNTER SPRING COMPANY

A Division of American Machine and Metals, Inc.
3 Spring Avenue, Lansdale, Pennsylvania

SPRINGS • STAMPINGS • QUALITY CONTROL EQUIPMENT

Circle 501 on Page 19

What some folks won't do to use a

CONWAY CLUTCH

Just take a gander at that contraption over that-away. Looks like a genuine vintage Rube Goldberg. What's it for? Shucks, can't you tell?

This, friends, is a Conway Variable Torque Clutch

Mechanism. Turn the wheel to the right—torque increases. Turn left and torque decreases. Now,

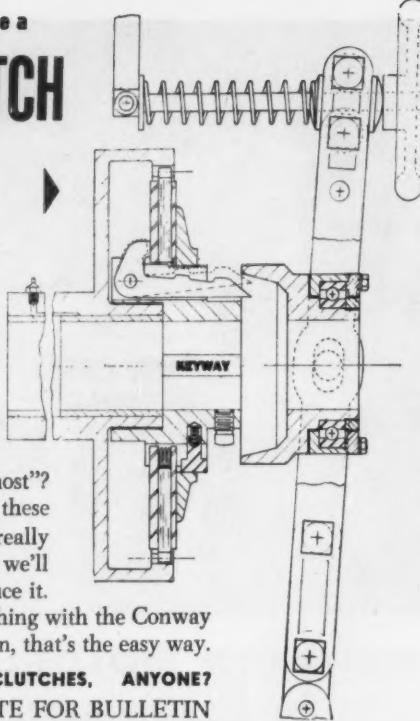
isn't that the "most"?

We hate to make these (confidentially, we really love it) and if you insist, we'll force ourselves to produce it.

And, you can do the same thing with the Conway *Stationaire*. But then, that's the easy way.

*SLIP CLUTCHES, ANYONE?

WRITE FOR BULLETIN



The World's Most Respected Name in Clutches for over a Half-Century

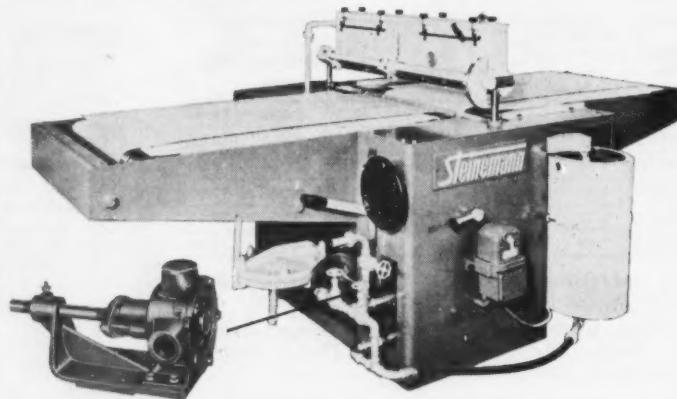
The CONWAY CLUTCH COMPANY

2750 Colerain Ave.

CINCINNATI 25, OHIO

Circle 502 on Page 19

HIGH EFFICIENCY USING VIKING PUMPS



THE MACHINE pictured above is a Pressure Curtain Coater for paint coating and finishing flat, textured, striated, corrugated and many other irregular flat surfaces. Developed, patented and manufactured by the Ulrich Steinemann Company of St. Gallen, Switzerland, the coating machine is also licensed for manufacture in the United States by George Koch Sons, Inc., Evansville, Indiana. Wilco Machine Works, Inc., Memphis, Tenn. are North American Sales Representative. Through exhaustive experiments and tests, Koch's proved that **VIKING PUMPS** were superior to any known or previously used equipment. They are now used internationally on Steinemann equipment, because of their efficient operation. **VIKINGS** help Steinemann machines achieve almost 100% total paint utilization.

This is one of many hundreds of cases where **VIKING PUMPS** play important roles as integral parts of equipment. If you have a situation requiring a smooth, even flow of material, or positive and complete control, check on **VIKING PUMPS**. For information, write for bulletin BH **VIKING PUMP COMPANY**, Cedar Falls, Iowa, U.S.A. In Canada, it's "ROTO-KING" PUMPS. See Our Catalog in *Sweet's Product Design File*.

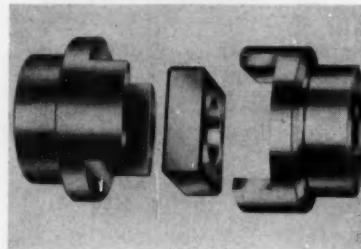


NEW PARTS AND MATERIALS

Pictures for the following two items were reversed in our issue of December 8, 1960. The write-ups are rerun below, with the correct photographs.

Flexible Coupling

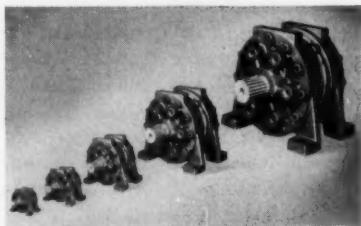
has center which retains lubricating oil



New flexible coupling utilizes an oil-impregnated center member of sintered steel. Through capillary action, center member absorbs and retains high-grade lubricating oil for long periods and dispenses it to bearing surfaces as needed. Unit maintains all misalignment capacity characteristics inherent in standard American jaw flange flexible couplings, and has greater torque and load-carrying capacity. Mechanical Power Transmission Div., Zurn Industries Inc., Erie, Pa.

Rotary Actuators

in five sizes with torques from 1500-702,000 lb-in.



Hydraulic rotary actuators for commercial use, called Hyd Ro Ac, are furnished in five different sizes. Torque range is from 1500 to 702,000 lb-in. at 3000 psi, and operating pressure ranges from 250 to 3000 psi. Units have an efficiency of 95 per cent or over, with low starting (friction) torque. They provide angular travel to 280 deg and can be foot or end mounted. Buffalo Hydraulic Div., Houdaille Industries Inc., Dept. Z, 537 E. Delavan Ave., Buffalo 11, N. Y.

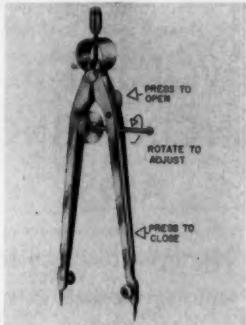
ENGINEERING
DEPARTMENT

EQUIPMENT

Bow Compass

permits adjustment
without threads

Model 12 quick-change bow compass incorporates handle adjustment in which no threads are used. Smooth, hardened rod is actuated by a hardened canting lever. Action, which provides a positive lock in any position and slow-motion adjustment when rod is turned, im-



proves with use. Channel-formed legs provide light weight and excellent balance. Capacity of the compass is over 6-in. radius. Dept. G, Omicron Co., P. O. Box 907, Glendale, Calif.

Circle 674 on Page 19

Pressure Transducers

have sensitive area
of 1 sq cm

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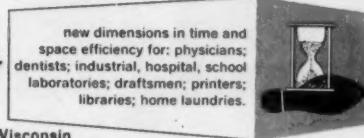


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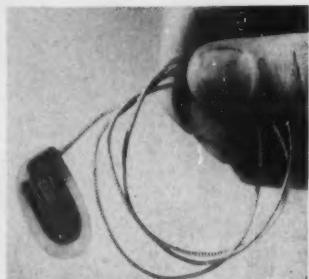
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ENGINEERING DEPT. EQUIPMENT



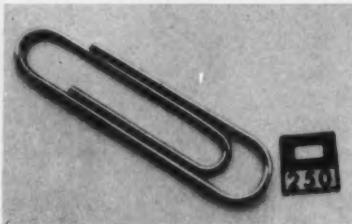
bridge or resonant circuits. Elastic elements are thin sheets of embossed high-strength alloy, dielectric is mica, and covers are Saran film. Spitz Laboratories Inc., Yorklyn, Del.

Circle 675 on Page 19

Temperature Indicator

miniature label has accuracy of ± 1 per cent

Model 200 Temp-Plate is useful for instrumenting transistors and other miniature electronic components, inaccessible machinery areas, and general industrial or aviation equipment. Measuring only $\frac{1}{4}$ -in. square, the tiny plastic adhesive tab sticks to almost any surface and turns black when its temperature reaches any desired value between 100 and 500 F. It provides an absolute rec-



ord of alarm-limit temperature. Pyrodyne Inc., 11973 San Vicente Blvd., Los Angeles 49, Calif.

Circle 676 on Page 19

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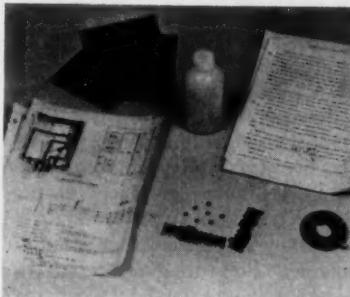
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Circle 509 on Page 19.



ing the desk. Advanced Designs Inc., 914 Lullaby Lane South, Vienna, Va.

Circle 677 on Page 19

Drawing-Board Surface

does not creep,
wrinkle, or stretch

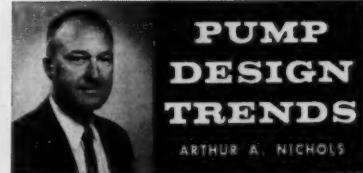
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Circle 678 on Page 19

Magnetic Tape Recorder

records dynamic data
from 100 to 5000 cycles

Three-channel Model PS-303M magnetic tape recorder measures 2 x 4



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► Now the development of three matched pumping elements permits designers to build-in a Gerotor pump as an integral part of any hydraulic mechanism or system.

► Consisting of an inner and outer Gerotor and an eccentric-locator ring, the unit becomes a complete pump by simply boring the casting or frame of the mechanism to accommodate the locator ring O.D. and by providing porting. This design makes the main casting do double duty as the pump housing, thus eliminating a very considerable cost factor. A drive can be taken from any convenient shaft. Obviously, such a built-in pump costs far less than complete pumps purchased outside. This results from the elimination of mounting pads, couplings, lines, connections and accessory drives.



Fig. 1. Three Gerotor components permit pump to be incorporated as integral part of housing or frame of mechanism, eliminate need for purchase and mounting of separate, complete pump.

► The matched elements are thus as easily built in as a simple anti-friction bearing would be. Further, the Gerotor pump is extremely flexible in its configuration and readily adapts to a wide variety of mechanism geometries. It will handle a variety of fluids at rates up to 100 gpm and pressures up to 1,000 psi. A simple, positive-acting automatic reversing feature can be built in at little cost.

► Typical examples of servo applications include ship anti-roll stabilizer control, steering mechanisms, and hydraulic piston positioning and actuation in a wide variety of industrial applications.

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Circle 511 on Page 19

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ENGINEERING DEPT. EQUIPMENT

x 5 in. and weighs 31 oz, including 7 oz of tape. Designed for direct recording of dynamic data in the range from 100 to 5000 cycles, recorder operates in any environment. Small size of the unit permits its use in many applications where conventional recording equipment is not adaptable. Accuracy of operation is completely unaffected by position or motion. Recorder requires $\frac{3}{4}$ -w power, supplied by standard mercury cells or other low-impedance power sources. It records a minimum of 1 hr at $1\frac{1}{8}$ ips tape speed. Frequency response is flat within 3db from 100 to 5000 cps. Precision Instrument Co., 1011 Commercial St., San Carlos, Calif.

Circle 679 on Page 19

Beam Compass Holder

has radii from 1 to 9 in.



Aluminum beam-compass holder is designed for use with Tape-Pen. Unit eliminates work with pen and pencil by drawing precise circles and arcs with narrow width Curve-Line tapes. Adjustable for making circles of various sizes, it has radii of 1 to 9 in. Additional standard-length beam sections can be coupled to the basic beam if longer radii are desired. Chart-Pak Inc., One River Rd., Leeds, Mass.

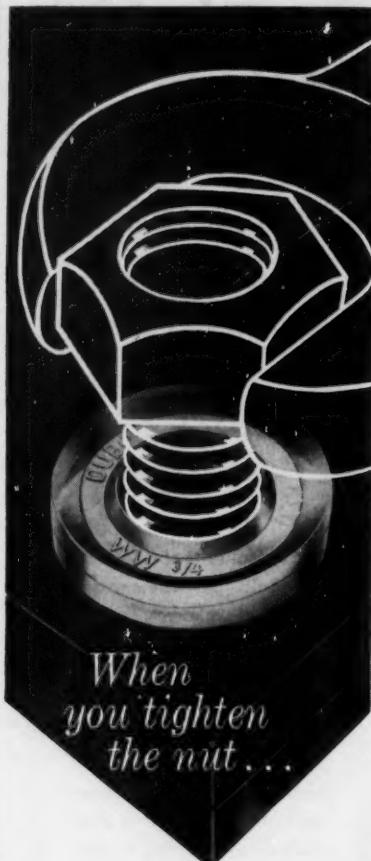
Circle 680 on Page 19

Photoelectric Tachometer

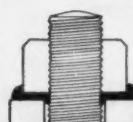
provides digital measurement
of shaft speeds

Photoelectric tachometer is available for the precise digital measurement of shaft speeds, particularly on sub-fractional motors. This is accomplished by the use of an integral light source, a 60-segment rotating interrupter, a photojunction cell, and a special transistor amplifier. Every 6 deg of shaft rotation results in a

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Patents Applied For

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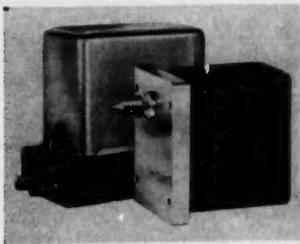
PLUS USES: The excellent electrical characteristics of NYLOGRIP Dubo Lockwashers make them ideal for electrical insulation, or to help control electrolytic corrosion between dissimilar metals.

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dc pulse of 2 v. Feeding the resultant square wave into a digital counter with a 1-sec time base gives an accurate reading of speed in rpm. Unit can be used to measure any speed from 0 to 25,000 rpm with a required driving torque of only 0.05 oz-in. at 3600 rpm. Tachometer is equipped with a versatile mounting arrangement. Servo-Tek Products Co., 1086 Goffle Rd., Hawthorne, N. J.

Circle 681 on Page 19

Piezoelectric Accelerometer

has range of 0.05 to 10,000 g

General-purpose Model EM900 piezoelectric accelerometer is operable in ambient temperatures from -100 to +500 F. It measures shock from 0.05 to 10,000 g and vibration to 10,000 cps with no measurable hysteresis observed. Mechanically-isolated mounting stud eliminates distortion in the accelerometer when it is mounted, or when there is motion from the connecting cable. Precision machining of noncorrosive, stainless-steel housing and shell, and



of the seismic mass, provides linearity of ± 1 per cent and low transverse sensitivity of 3 per cent. Low-noise, 4-ft, detachable cable is furnished with each unit. Weight of the Model EM900 is 35 grams. Industrial Components Div., Raytheon Co., 55 Chapel St., Newton 58, Mass.

Circle 682 on Page 19

February 2, 1961

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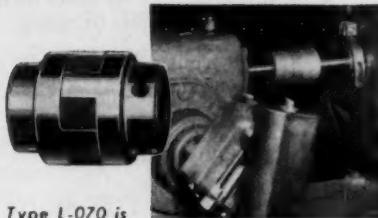
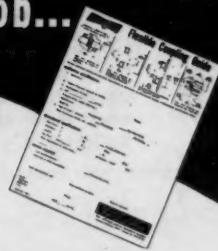
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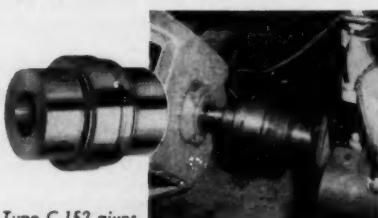
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Recent Books

Off-The-Road Locomotion: Research and Development in Terramechanics. By M. G. Bekker; 220 pages, 6 1/4 by 9 1/4 in., clothbound; published by University of Michigan Press, Ann Arbor, Mich.; \$10.00 per copy.

Mechanics of land locomotion is thoroughly covered. General areas of discussion include current concepts of locomotion; physical properties of soil, mud, and snow; geometrical properties of terrain surface; flotation and vehicle performance; and theoretical concepts and engineering.

Analogue Computers. By I. I. Eterman; translated from Russian by G. Segal; translation edited by B. H. Venning, University of Southampton; 264 pages, 5 1/4 by 8 1/4 in., clothbound; published by Pergamon Press Inc., 122 East 55th St., New York 22, N. Y.; available from **MACHINE DESIGN**, \$8.50 per copy postpaid.

Theoretical—rather than practical—problems connected with analog computers are considered. Particular attention is paid to mathematical sections of analog-computer theory.

Detailed information is given about various methods of applying the machines to secure particular mathematical conditions for a solution. Problems associated with control of accuracy of solution are also treated in detail.

New Standards

Screw-Thread Standards for Federal Services, 1957, Part III. 66 pages, 7 1/4 by 10 1/4 in., paperbound; published by National Bureau of Standards, Office of Technical Information, Washington 25, D. C.; \$0.60 per copy.

This volume was issued in October, 1960, and completes the three-part subdivision of 1957 NBS Handbook H28. Included are Acme, stub Acme, and buttress threads; rolled threads for screw shells of lamp holders and unassembled lamp bases; microscope objective and

nosepiece threads; ISO metric threads; Class 5 interference-fit threads, trial standard; and miscellaneous threads.

American Standard, ASA B3.10-1960, Requirements for Instrument Precision Ball Bearings. 11 pages, 8½ by 11 in., paperbound; published by American Standards Association Inc., 10 East 40th St., New York 16, N. Y.; \$1.00 per copy.

This revision supersedes ASA B3.10-1959, and redefines characteristics of instrument precision ball bearings. Boundary dimensions and tolerances, size classifications for selective assembly, internal radial clearances, and other requirements are covered.

First Revision—Standards of the Hydraulic Institute—10th Edition. 75 pages, 8½ by 11 in., punched for loose-leaf folder; published by Hydraulic Institute, 122 East 42nd St., New York 17, N. Y.; \$1.25 per copy.

These pages contain revised and updated standards of the original tenth edition published in 1955. Significant changes include clarifications and corrections involving drawings, nomenclature, and text; new definitions for flooded suction, specific speed, and self-priming pumps; revision in test code for centrifugal pumps; and dimensions of NEMA type C face-mounted motors.

Government Publications

OTS Technical Reports. Copies of reports listed below are available from Office of Technical Services, U. S. Dept. of Commerce, Washington 25, D. C.

PB 161672. Endurance Tests of Rolling Contact Bearings of Conventional and High Temperature Steels under Conditions Simulating Aircraft Gas Turbine Applications. By H. G. Walp, R. P. Remorenko, and J. V. Porter, all from SKF Industries Inc.; 78 pages, 8 by 10½ in., paperbound, side-stapled; \$2.25 per copy.

Tests were conducted at two temperature levels, and at normal and high speeds. To provide means for determining fatigue properties of materials without using complete bearings, simple specimen-testing machines were designed. Results are tabulated and discussed.

PB 161737. Refractory Inorganic Materials for Structural Applications. By Harry A. Pearl, Joseph M. Nowak, Joseph C. Conti, and Raymond J. Urode, Bell Aircraft Corp.; 141 pages, 8½ by 10½ in., paperbound; \$2.75 per copy.

Thirty-five refractory inorganic material systems were investigated. Fabrication techniques were evaluated by results of room-temperature modulus of rupture, impact, and thermal-shock tests.

SB 410. Bearings (1945-1960). 17 pages, 8 by 10½ in., paperbound, stapled; \$0.10 per copy.

Research reports on roller, journal, ball, friction, antifriction, and gas-lubricated bearings are listed in this selective bibliography. Reports on casting, lubrication, cooling, testing, and inspection of bearings are included.

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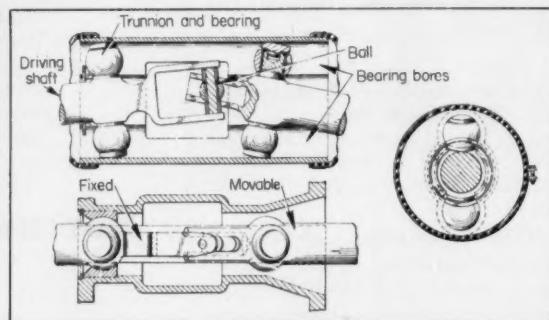
CHICAGO LOCK CO.
2054 N. Racine Avenue • Chicago 14, Illinois

NOTEWORTHY

Patents

Constant-Velocity Universal Joint

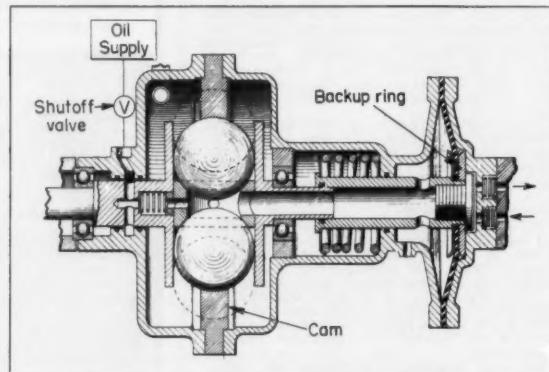
A double-pot type universal joint is self-centering and provides nearly constant angular velocity by compensating for axial movement of the driveshaft. During operation, the entire housing rotates, both the driving and driven shafts being keyed to the housing by a trunnion-and-bearing assembly. Universal action is provided by a ball-joint which rides in a groove in an



extension of the driven shaft. The driven shaft is thus free to move axially to compensate for shaft deflection. Because this shaft movement does not change the center of gyration of the ball, the variation in the universal joint's angular velocity is negligible. Patent 2,964,928 assigned to General Motors Corp., Detroit, Mich. by Donald Peter Marquis.

High-Volume Diaphragm Pump

An annular backup ring strengthens a flexible pumping diaphragm, increasing the effective displacement of a pump and allowing large volumes of fluid to be

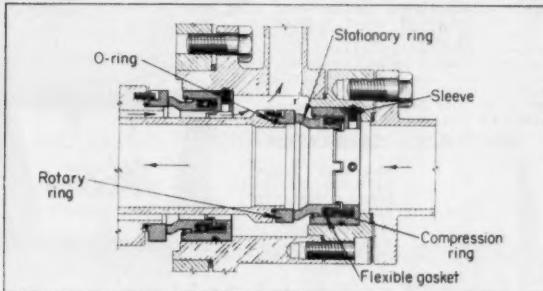


moved. Operating fluid is completely isolated from the pumped fluid by the diaphragm. A reciprocating-ball pump provides a pulsating operating pressure to actuate

the diaphragm. At peak pressure, the diaphragm is moved toward the outlet port; at low pressure the diaphragm is returned by a spring. On-off control of the pump is provided by a shutoff valve, eliminating the need for a clutch. *Patent 2,953,096 assigned to Thompson Ramo Wooldridge by Achilles C. Sampietro.*

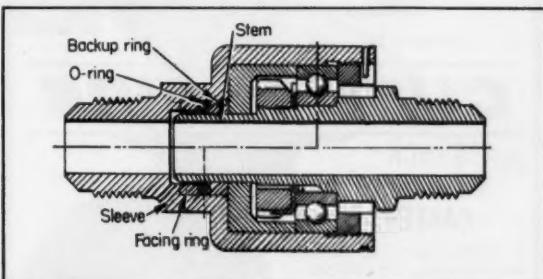
Compensating Rotary Fluid Seal

A seal designed primarily for use between rotary and stationary fluid passages adjusts automatically for any axial play caused by surges in the system. In addition, an O-ring between the rotary ring of the seal and the rotating fluid passage allows for axial misalignment. System pressure acts on the compression ring, forcing the flexible gasket to move forward and to seal against

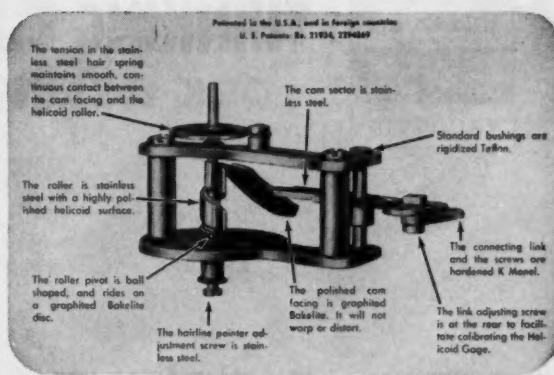


the sleeve and the stationary ring. As the flexible gasket moves forward, it forces the sealing face of the stationary ring into contact with rotary ring. The flexible gasket and its bearing spring expand and contract to compensate for any axial play. *Patent 2,964,340 assigned to Continental Oil Co., Ponca City, Okla., by Ora A. Kinzie and Hubert J. Watts.*

Extreme-Condition Swivel Joint



A swivel connector for high-pressure, high-temperature fluid lines uses a rubber O-ring with a Teflon backup ring for sealing. Pressure on the O-ring, as well as system heat, causes the backup-ring material to flow. Thus, the backup ring is always in contact with both the stem and the rotating sleeve, preventing extrusion of the rubber O-ring under pressure. An antifriction thrust bearing is used to provide friction-free swiveling action and to absorb thrust loads. *Patent 2,963,304 assigned to The Youngstown Sheet and Tube Co., Youngstown, Ohio, by Harold Comlossy Jr. and Robert R. Heden.*



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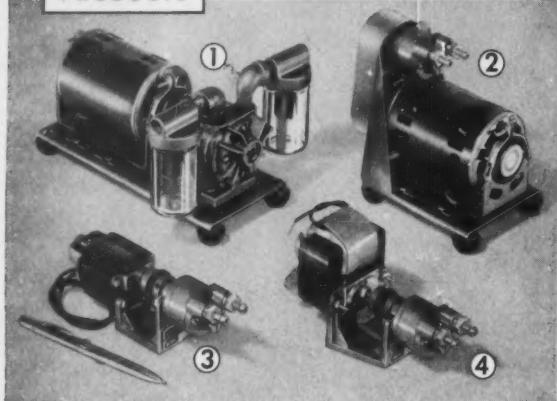
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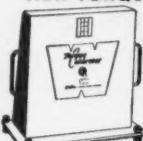
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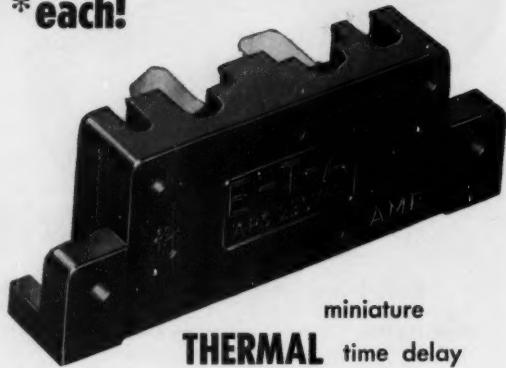
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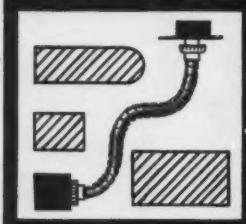
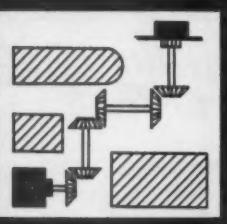
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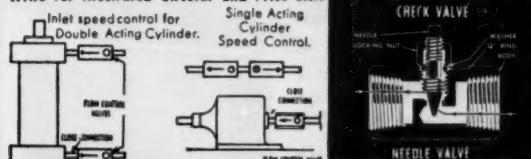
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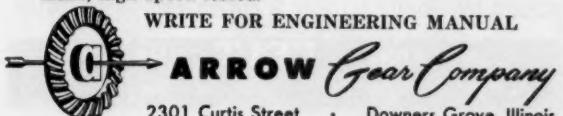
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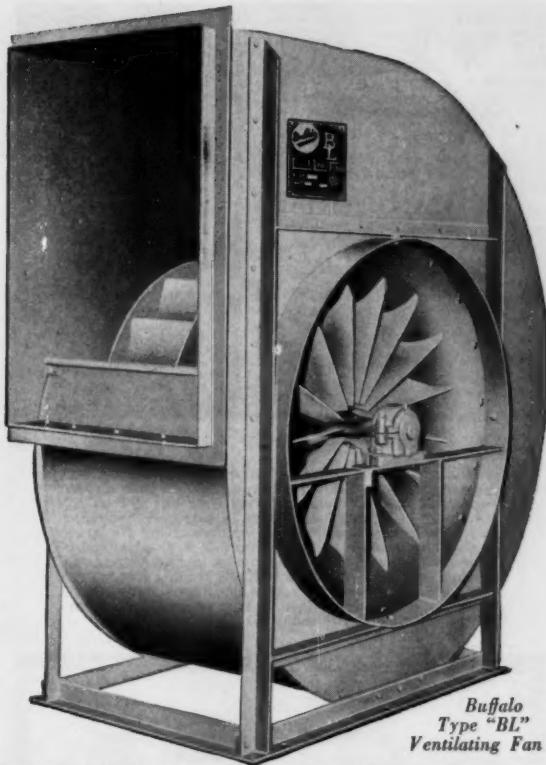
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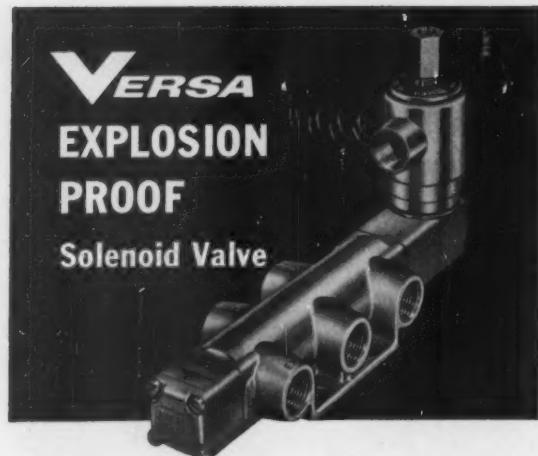
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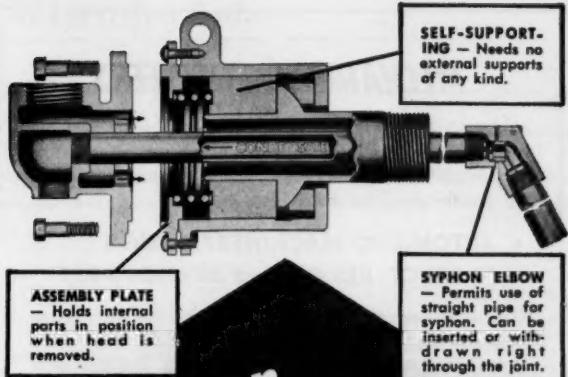
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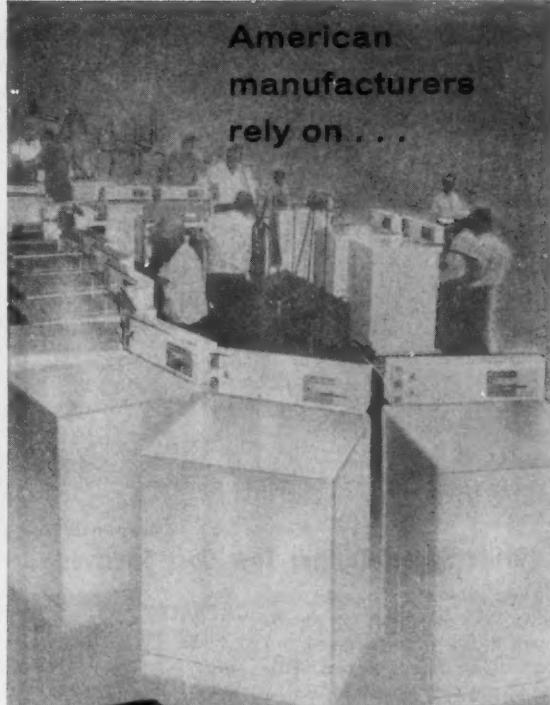
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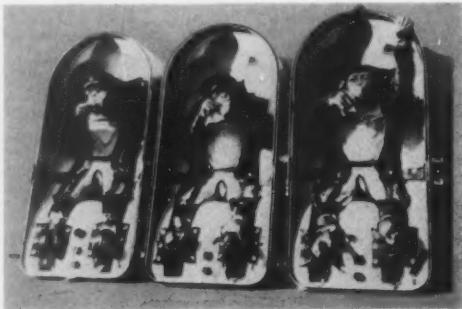
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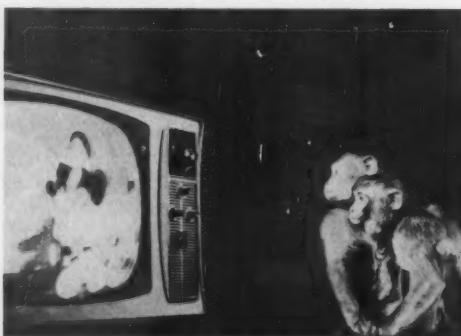
backtalk—

—Project Mercury Preliminaries

Preceding man into space, even as Darwin explains they did on earth, the simians are pretty nonchalant about their pioneering.



Duane, Jim, and Chu, three of 75 chimpanzees in training at Holloman AFB for an actual space flight, look as though they enjoy dressing up in space suits and trying capsules on for size. Chu is even practicing a farewell wave (or is he trying to get out of the thing?).



Meanwhile, back from a simulated flight, two Rhesus monkeys hurry to their television set. These Mickey Mouse fans are equipped with permanently implanted radio transmitters to broadcast physiological data during "flight." Acceleration, vibration, noise, and other stresses of blastoff have produced no ill effects on the pair; anxiety over Mickey's fate, however, seems to upset them considerably.

—A Rather Sharp Dim View

Fancy what William Cowper would have had to say about space travel! (You remember William Cowper: English poet, 1731-1800.) Our reading recently gave us the opportunity to learn his viewpoint on man's desire to fly:

... if a power to convey himself from place to place, like a bird, would have been good for

[man], his Maker would have formed him with such a capacity. . . . it is easy to prognosticate a thousand evils which the project must necessarily bring after it; amounting at last to the confusion of all order, the annihilation of all authority, with dangers both to property and person and impunity to the offenders. Were I an absolute legislator, I would therefore make it death for a man to be convicted of flying, the moment he could be caught; and to bring him down from his altitudes by a bullet sent through his head or his carriage, should be no murder.

While he was a bit harsh on the would-be airmen, Mr. Cowper showed remarkable foreknowledge of the "thousand evils" attendant to this mode of travel. Anyone who has spent any time at an airline terminal on a stormy day surely knows what he meant by "the confusion of all order and the annihilation of all authority."

—Coffee, Tea, or Sound Track?

Don't get the idea that we're anti-aviation—indeed, if Bill Cowper were running things today, we would fly even on pain of a bullet through our head or carriage.

We not only greatly admire the ever-improving machinery of the airplane, but look forward to the services which are always being added. This spring, for instance, TWA will show first-run movies on nonstop jet flights between New York and California, and on some transatlantic flights.

In-Flight Motion Pictures Inc. (who else?) developed equipment for showing the films, including lightweight head sets with individual volume controls for those passengers who choose to watch.

—Motors, Electric and Outboard

A contest that doesn't require you to display your design-engineering skills (but presumes that you possess such skills) is announced by Franklin Electric Co. Inc. Franklin seeks a name for its new aluminum motor; submitter of the best name will receive a 16-ft aluminum runabout and a 40-hp outboard motor. The 21 next-best names will be good for runner-up prizes of aluminum golf carts. Information on the new motor and entry blanks are available from Franklin Electric Co. Inc., Bluffton, Ind. The contest closes Feb. 28. And remember—only design engineers can enter.

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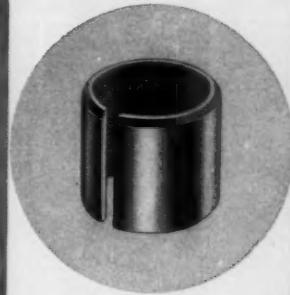
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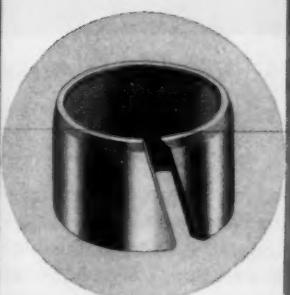
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You're buying motors by the pound when price is the only consideration

Sure, you can get a motor for the lowest price, a motor of the same type and with the same rating and operating characteristics of the highest priced motor. But, while initial price is an important factor, the actual cost is the ultimate cost of a motor. And, ultimate cost includes the repair bills, lost production, lost man hours and lost customers that an inferior, built-down-to-a-price motor could cost you.

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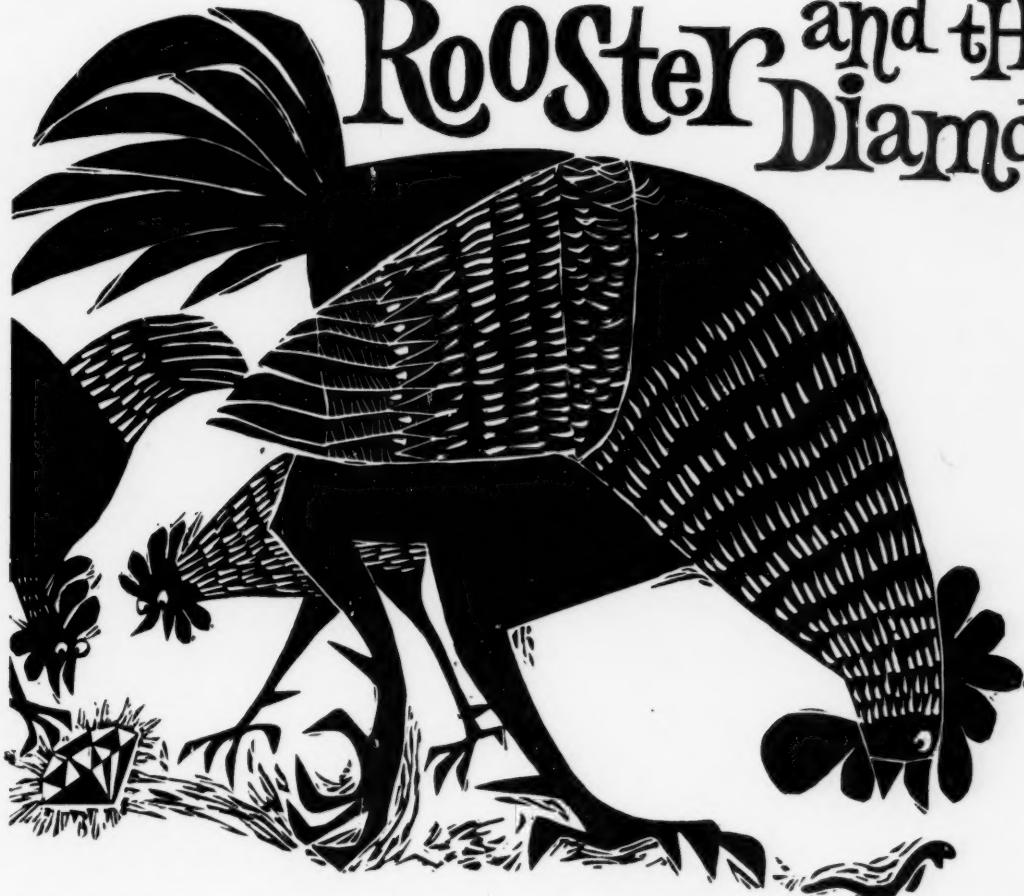
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WH61-3

proper values the Rooster and the Diamond



A rooster was scratching around in his barnyard, looking for corn and worms. He came upon a brilliant diamond which someone had lost. // All the hens fluttered around to see and admire its sparkling beauty. But the rooster went on with his scratching elsewhere. // "No doubt, it's a fine item for those who can use it," he mused, "but I want nothing more than to keep on finding food."

moral: Don't let fancy outshine value.

We don't crow too much about fancy cylinder features. Keeping your machines in motion is our satisfaction. But when two important new advantages we know you can use are designed into Hydro-Line cylinders, we like to explain how they can help you increase productivity and meet shipping deadlines.

Rod seals and wipers for our series N2 hydraulic cylinders are made from DuPont's Viton®—highly resistant to heat and hydraulic fluids. (Viton seals and wipers are optional, at slight additional charge, on series R2 cylinders.)

Chrome-plated barrels for Hydro-Line air cylinders virtually eliminate scoring in rugged applications. Corrosion is eliminated, even where condensation is unusually severe.

Look in *Sweet's Product Design File* for dimensions of our standard stock cylinders, ready for "off-the-shelf" delivery. Check the address of your nearest Hydro-Line representative. Then ask him to help you select the correct cylinder for hydraulic applications to 5000 psi and air operations to 200 psi. Or, phone TRemont 7-5758 to contact the factory direct.

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5602 PIKE ROAD, ROCKFORD, ILLINOIS, manufacturers of:
high- and low-pressure hydraulic cylinders • heavy-duty air cylinders • adjustable-
stroke cylinders • dispensing cylinders • intensifiers • single-acting cylinders • boosters • rod end couplers



Circle 402 on Page 19



C/R did the trick...

Specially compounded and molded parts gave this manufacturer the competitive edge he wanted!

Hydro-Line Manufacturing Company posed this problem to C/R: produce an elastomer rod seal and dirt seal with the highest possible resistance to wear (equal or superior to Buna-N) — that will function dependably in air at temperatures ranging from -40° to 450° F. Further, the seals must be compatible with the widest range of industrial hydraulic fluids.

C/R† Sirvane engineers selected Viton-A* as the base material. They specially compounded it, pigmented it to permit distinct color-coding, then molded the rod seal and auxiliary dirt seal you see

above to precise tolerances. These seals have wear-resistance equal or superior to Buna-N. They have the highest continuous service temperature resistance of *any* elastomer on the market, and their compatibility will assure long service life in virtually all industrial applications. The manufacturer is able to standardize — safely and economically.

C/R† can do the same for you. We have the special techniques, knowledge and facilities to help you give your product a competitive advantage. Call or write for immediate information or engineering assistance.

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